TARR & McMURRY'S

GEOGRAPHIES

SUPPLEMENTARY VOLUME

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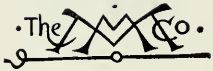
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TARR AND McMURRY GEOGRAPHIES

SUPPLEMENTARY VOLUME

UTAH

BY

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PREFACE

In writing this Supplement the object has been to arrange facts in the natural order, both genetically and chronologically. A teacher using this book will find geological data together and at the beginning. He will find mining camps grouped with an account of minerals and their origin. Topography and drainage, being conditioned on geological history and dynamics, follow them. The various valleys are described as units, to lay the foundation for the grouping of the cities and towns later on. Since the life is conditioned on climate, it necessarily follows climate. Vegetable and animal life come first because they were first. Irrigation, agriculture, and stock-raising depend upon the plant life, and therefore follow it. Since the human life is conditioned on these, it comes last of all.

Another object of this book is to show that it is but a primer of Utah geography. In the Search Questions are many things which cannot be answered by the pupil or teacher without original research and study. These questions are therefore to be used as topics of discussion rather than required work. They are things to set the pupils thinking and investigating for themselves, and to show

that there is much more about Utah which has not been mentioned than is found in this book.

All the maps have been drawn from original data by Miss Clara Brooks of Salt Lake City, under the writer's immediate supervision. The writer is responsible for the topographical features in all the maps and for the limits of life zones in the zonal map. Most of the illustrations are from photographs taken by the writer. A few are from those taken by C. R. Savage and Miss Brooks, and the illustrations of coal mines are furnished by Mr. W. F. Colton.

M. E. J.

UTAH SUPPLEMENT

Introductory Questions. — Locate Utah exactly on the map of the United States. What states and territories border Utah? Draw from memory an outline map of Utah with the names of states and territories on the border. Make a dot to indicate the position of each of the five large cities. Give some of the reasons why they are situated where they are. Why was Salt Lake City not located at Green River? Does Utah have greater natural advantages than Colorado, Nevada, California, or New York? Give your reasons for and against. Is Utah specially well located as regards travel and commerce? Why? What is its rank in population and area? (For reasons see table.) Between what parallels of latitude and meridians of longitude is Utah? In what zone is Utah? As to climate, what life zones are represented in Utah? Describe the relief of the state. What three great drainage systems are represented in Utah? How many of these are worthy of mention? Within the Great Basin, how many smaller systems can you find? What is the climate of your locality? How does it differ from Salt Lake City or St. George? What parts of the world have relief like certain parts of Utah? Crops? Climate? What five regions are entirely different?

What cities of the world are on about the same parallel of latitude as Salt Lake City? Are their climates the same, and why? Take railroad folders and find the distance from Salt Lake City to San Francisco, Denver, Omaha, Chicago, and New York City. If it takes you an hour to climb 1000 feet straight up, how long would it take you to climb from the ground at New York City to the level of Salt Lake City?

Utah is situated in the lower third of the North Temperate Zone, though as to climate, the southwestern part is in the Tropical Zone, and the highest mountain tops in the Frigid Zone (Fig. 33). The average elevation of the valleys is about a mile above the sea, and of the mountains two miles (Fig. 12).

CHAPTER I

GEOLOGICAL HISTORY

Geological History. — The two great sets of forces which produce surface structure are internal and external. The internal forces show themselves in extensive movements of the earth's crust, by which it is wrinkled, split, and twisted, causing lofty mountains, plateaus, valleys, volcanoes, lava flows, and hot springs. The external agencies are *temperature*, *water*, *ice*, and *wind*. These produce erosion and deposition, twin sisters, which take the surface where the internal (also called dynamic) forces leave it; they cut, smooth, and fill up, till in the end they return it to the condition in which the other forces found it. Man comes upon the Earth while this contest rages between the forces, and can exist only while it lasts.

The first land which appeared in the west was in Colorado, Arizona, and Nevada, but there was none in Utah till the Coal Age, when a low area in the Salt Lake City region and westward appeared. This land had dense vegetation which is now turned to graphite and anthracite in the Wasatch, because it was afterward sunk below the ocean and covered very deeply with water and sediments, which caused the change into coal.

At the end of the Coal Age all of Utah, west of a line running from Salt Lake City to Nephi and thence to Kanarra, was lifted out of the sea in a lofty plateau, and wrinkled into nearly parallel mountain ranges running

probably northwest and southeast. This region was drained by at least three rivers which emptied into the sea at Salt Lake City, Thistle, and Kanarra, as is shown by the great beds of red sandstone at these places. (Fig. 3 shows some of this sandstone; also Figs. 15 and 16.) Later this shore line was extended eastward a few miles, and part of the sea was cut off and dried up around Nephi and Salina, forming great beds of gypsum and salt.

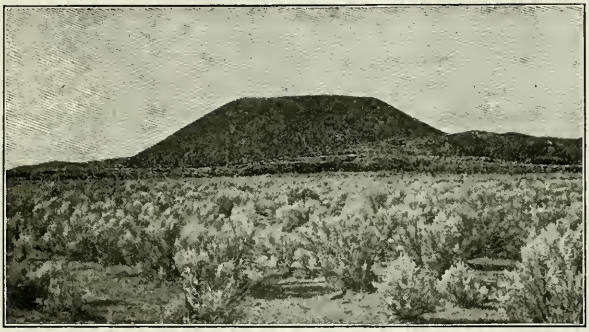

FIG. 1.

Volcano in Diamond Valley, above St. George. Notice the lava-flow at the base. This ran down the present valleys nearly to Santa Clara. It is hardly grass-grown. Sagebush in the foreground.

Thus we find warring forces at the foundation of Man's prosperity. We find provision being made for Man's use in the coal beds, perhaps ages before he came on the Earth, and we find a plateau slowly rising out of the sea, sloping southeastward and having mountain ranges and large rivers, the former furnishing and the latter carrying away the material which at a later date was to cover the great forests of eastern Utah and turn them into coal (Figs. 19, 20).

During the Utah Coal Age (Cretaceous), the sea bottom

of eastern Utah east and southeast of Salt Lake City was now above and now below the sea, at one time densely covered with vegetation and at another by mud and sand, till 2000 feet or more of such beds were formed, including several coal veins. Some of them were 40 feet thick. From these comes our coal, and though most of this area has been worn away, there still remain about 7000 square miles of coal land. The same agencies which formed the coal also caused the oil, asphalt, and gas strata.

At the end of this Age all of Utah was raised above the sea; the Wasatch and Uinta mountains were formed into great whalebacks, rising above the other land like logs half buried in it; and a large fresh-water lake east of the Wasatch surrounded the Uintas and extended southward to Glendale in Utah, and thence nearly to the mouth of the Colorado in Arizona. The drainage was into this lake. The bed was broken up into great blocks of different elevation, but not into mountains. The Colorado River, the outlet of the lake, rapidly wore its way back, forming the Grand Canyon of the Colorado, until it completely drained the lake. Then the present structure was produced by the Great Basin region (which hitherto had been a lofty plateau) sinking bodily to about 4000 feet above the sea and becoming a basin. During the sinking of this area it was also split up by cracks or breaks running north and south and cutting the old mountain ranges diagonally. These cracks crossed the valleys as well as the ranges, continuing sometimes for many miles. As soon as they were formed the country on one side of the cracks sank down, making valleys, and the other side rose up, producing new mountains which ran north and south.

This peculiar origin of the Basin ranges accounts for

the fact that nearly all of them are high in the middle and taper down to the plain at both ends, where they disappear, only to rise again in another range farther on. When first formed they were continuous ranges with very lofty centres and with low depressions where they crossed old valleys. But the time since their formation has been so great that the débris worn from them has left only the old mountain parts standing, while the depressions have been covered by the great plain and do not appear above the general surface. The ranges now remind one of a string of whales swimming in single file through a sea.

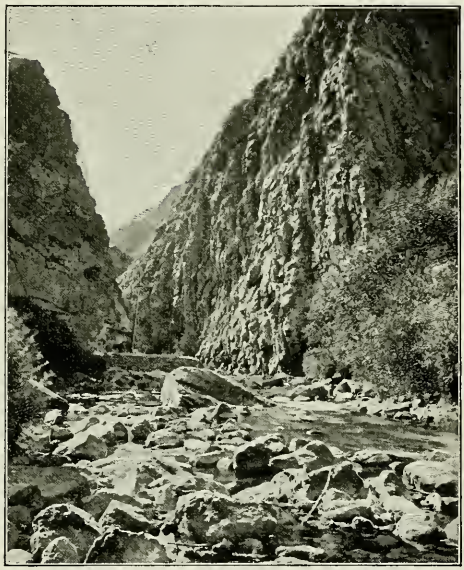

FIG. 2.

Mouth of Ogden Canyon, showing the ancient rocks standing nearly vertically, a V-shaped canyon. The stream is full of trout and is overhung by willows.

When the Great Basin sank, both the western and eastern edges, which were represented by the two whalebacks, the Sierras and Wasatch, split along their crests from one end to the other. The eastern side of the Sierras and the western side of the Wasatch sank thousands of feet, forming very deep valleys, while the other side stood up

in great serrated mountain ranges which were precipitous on the broken face and sloping on the other. At first the two valleys thus formed were very deep and the ranges of great height (unless, as is quite probable, they were formed gradually), for the difference between the bottom of the Salt Lake Valley and the crest of the Wasatch was then about 40,000 feet, or about eight miles vertically; but since that time the valley has filled up with débris from the Wasatch to a depth of at least 13,000 feet, and the range has been correspondingly cut down (for erosion and deposition are equal). Now the greatest difference between the crest of the range and the valley is only 8000 feet.[1]

At the north, above Logan, though the splitting of the Wasatch took place, the two edges slipped by each other but little and sank together, so that the fresh-water lake north of the Uintas spread out over Utah into Nevada, and formed a lake extending from the Sierras to the Wasatch. (Figs. 45, 50, and 52 show the Wasatch cliffs.)

In comparatively recent times, probably since Man came on the Earth, this latter body of water was divided by an elevation of land in Nevada, and was also cut off from Wyoming, forming two lakes. The western is called Lake Lahontan and the eastern Lake Bonneville. The latter had its outlet into the Snake River (see Fig. 27).

It is also probable that at this time the present watershed of the eastern side of the Great Basin was formed by the elevation of the whaleback (now only the western half of it is left) called the Coal Range (Wasatch Plateau), which runs from the Uintas south

[1] This does not account for the difference between 26,000 feet and 40,000 feet, but it should be remembered that the remaining débris was spread out over a part of the bed of Great Salt Lake.

through Colton to Cannonville and thence westward to Nevada. This added the Weber, Provo, and Sevier rivers and desert to the Great Basin area, though the last two were at first a part of the Colorado River drainage (St. George region) till cut off by lava flows. (Views of parts of the Coal Range are found in Figs. 4, 19, and 43.)

Before the formation of the two lakes in the Great Basin, the climate, which had been tropical and very moist,

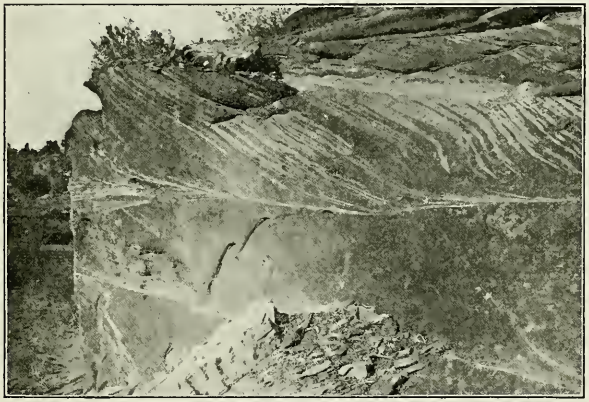

FIG. 3.

Cross-bedded sandstone near Kanab, showing the way in which it is formed.

became very dry and probably cooler. The lake dried up for the most part, and much alkali accumulated over the exposed areas. It filled the beds of half-decayed plant remains with salty water, and thus laid the foundation for the production of gas and oil, later. These beds now exist from Salt Lake City to Corinne. Afterwards the climate gradually grew colder till it culminated in the Ice Age.[1]

[1] The time since the Ice Age is variously estimated from 10,000 to 120,000 years. The state of preservation of the old beaches of Great Salt

At this period the temperature was so low that the evaporation became less than the rainfall; and therefore the empty basins filled with water. The soil became sweet again; the mountains were covered with masses of snowy white; and the valleys teemed with Arctic life, because the climate was frigid.

Thus we find that great coal beds were made, which now supply Utah with fuel at a time when her forests have disappeared. We find strata containing natural gas, oil and asphalt, building stone, etc. We find the region elevated, drained, and cut so as to make the coal and gas deposits accessible. We find the Wasatch and Uintas elevated, and the open valleys partially filled. A tropical climate prevailed at this time, and the moist air doubtless supported a dense vegetation of palms and ferns. Following this, man appeared. The climate became very dry and cooler. A great lake was formed, extending from the Wasatch to the Sierras. This body of water afterward was divided, and the eastern part became the forerunner of Great Salt Lake. This lake, in the Ice Age, was full of fresh water. (*For old beaches, formed by the lake at this time, see Figs.* 27, 28, *and* 29.)

Volcanoes.—In the process of continent building, one of the lesser products is the volcano with its outpouring of pudding-stone, ashes, pumice, and lava. The volcano is found only when the great breaks in the rocks are such that they permit the melted rock to come to the surface from below in so fluid a state that it boils out and builds up a cone; but the more common case is where the fissures or breaks are filled with melted rock which becomes too cool to flow before it reaches the surface. This material

Lake indicate clearly that the time elapsed is less rather than more than is generally supposed.

is seen only when the rocks are worn away by the elements, or cut by shafts and tunnels. A general name given to these underground eruptive rocks is porphyry dykes, and upon them depend almost all our mines, for without porphyry there are practically no mineral veins. Volcanoes were common in Utah at all stages of its history, but were most abundant just before the formation of Lake Bonne-

FIG. 4.

Great clay hill near Thompson's Springs, showing the manner of weathering. A typical desert.

ville. Some continued till recently (or only a few hundred years ago).

The greatest of our ancient volcanoes was Mount Belknap, which burst out on the western side of a limestone mountain nearly a mile high, but soon overtopped and covered it with 2000 feet of lava, while its cone towered probably 15,000 feet above the sea. After it ceased to erupt, smaller cones burst out at its base. One has large sulphur deposits, and another has fine pumice stone. Many volcanoes do not come from fissures, but force their way up through level and unbroken ground in what are called chimneys (because of their likeness to chimneys of houses. The Fish Lake region is an example of this,

having immense lava flows also (Fig. 8). Fish Lake probably covers the crater of one of the vents. An example of volcanoes that did not come to the surface, but lifted up the strata in a great dome without bursting through, is found in the Henry Mountains. Sevier Valley is full of old volcanoes, as is also the country around Fillmore, Dugway, Fish Springs, and in southern Utah. The most perfect and the youngest volcanoes are those at Oasis and Diamond Valley above St. George (Fig. 1).

We find volcanoes are the vents of underground masses of melted rock which come up along fissures, or bore their way through the overlying strata, forming chimneys. Volcanoes often have sulphur and pumice deposits near the old craters, and the lava often makes good building stone.

Hot Springs. — These are nearly always associated with some lava flow or volcanic movement, and are caused by water flowing over heated rocks on its way to the surface, and dissolving more or less mineral matter. Some springs are brackish, some carry iron, copper, sulphur, or lime, and many carry several of these elements. The most noted are the brackish iron springs at Ogden, the salty springs of Salt Lake City, Castilla, Grantsville, Lehi, Sevier Desert, Midway Pots, Monroe, Richfield, Milford, and the Rio Virgin. Nearly all are famed for the cure of rheumatism and painters' colic, called "leading." Some are boiling hot; some are warm; some are cold.

QUESTIONS. — What are the two sets of forces causing earth structure? What are the effects of each? Why cannot Man exist after these forces cease to act? When and in what part did land first appear in Utah? What covered it, and what became of this covering? What part of Utah first rose above the sea to stay? When? What was its slope and surface? Where did its rivers

empty? How came salt to be formed a little later? Where and how were the great coal beds formed? How much is left of them? When were the Wasatch and Uintas formed? Why is the western side of the Wasatch so steep? Why do most of our mountains have one face steep? What occupied eastern Utah after the Wasatch and Uintas were formed? Trace its boundary on the west. What was the slope of Utah then? When was the Great Basin formed, and how? What filled it at first? What became of it? How was Lake Bonneville formed and what was its outlet? When was the Coal Range formed? Did it add to the Great Basin or change the drainage? What was probably the original outlet of the Sevier River? What was the climate at first and how did it change? Why did the dry basins fill up? What is a volcano? What does it produce? What is the common name for underground eruptive rock in fissures? What valuable deposits are caused by it? What was the greatest ancient volcano in Utah? Describe it and its products. Have there been recent volcanoes in Utah, and where? Have you seen any? Mention volcanoes that did not come up through fissures. What came up near to but not through the upper strata, and what did they cause? Where are old volcanoes the most common in Utah? How did hot springs originate? Do they differ, and how? Mention five prominent ones. If you have seen any describe them.

Search Questions. — How do geologists determine the early history of the earth? Why cannot Man exist when the warring forces cease? Why are anthracite and graphite grouped together, and how are they formed? Why are salt and gypsum beds associated? What kind of vegetation existed in the Coal Age? What is the Utah Coal Age? What conditions are required for the production of oil, gas, etc.? (See Petroleum.) Would the change of a wet to a dry climate alter the vegetation? Will a salty soil support the same vegetation as one not salty? Would there be gas near Salt Lake City had the climate been moist just before the Ice Age? Will a permanent change in temperature alter the vegetation? Why do volcanoes build up cones? Why are the craters reversed cones? Why do hot sulphur springs cure leading poisoning?

External Forces; Erosion and Deposition. — *Erosion* is the wearing down of material; *deposition* is the carrying away, spreading out, and laying down of this material.

They are complements of one another, for what is taken from one place must be laid down in another. Were it not for erosion the earth would not be habitable, because there would be no soil for plants, no plains for cultivation; the mountains would be too high and the valleys too low.

The chief factor in erosion is water, though ice and wind play minor parts.

The rapidity of erosion is governed by the slope, rainfall, hardness of the material worn off, and the amount of grit in the water, but not by the amount of surface covered. Therefore the immense quantity of débris worn off from a great area need surprise no one, for it is only as much in proportion as it would be over an acre. When the sea bottom is first raised above the water the top layers will wash off with great rapidity, because they are mud; but the hard rock, which lies far below, when reached, will wear away with great difficulty. (Such rocks are represented in Figs. 2, 5, 6, 7, 9, 10, 17, 27, 54, etc.)

The carrying power of water increases sixty-four fold every time the speed is doubled. The speed of water is governed by the slope, the straightness of the channel, and freedom from obstacles. It is, therefore, evident that a bare slope and a straight canyon are suitable conditions for cloudbursts, while a grassy slope or one covered with brush or trees will prevent cloudbursts. A cloudburst is, in Utah, understood to be the destructive torrent which is the product of a heavy rainfall on the bare watershed of a stream. The selective power of water of varying speeds results in the dropping of great boulders at the mouths of the canyons, because the moment the confined stream comes out of the canyon the water spreads, and its speed and

carrying power are greatly reduced. Therefore it drops the large boulders first, carries others farther on, and parts with the fine sand and mud last of all. This results in the building up of what are called alluvial cones, which are so characteristic of the arid West.

The formation of deltas, benches, and bars at the mouths of streams in lakes follows the same law as applied to

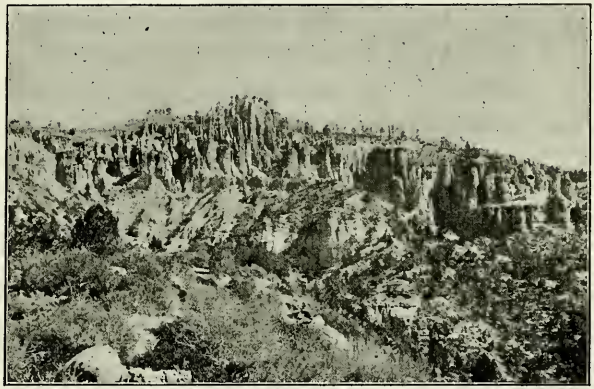

FIG. 5.
Erosion of the Pink Cliffs, near the Colorado River.

lake currents and waves, which have produced such conspicuous features in the old shore lines of Great Salt Lake. Examples of these are the Provo, Ogden, and Tooele benches. Great bars are found at the point of the mountain south of Draper, and at Stockton. Old beaches occur throughout Salt Lake Valley and along the mountains north to Collinston and west to Deep Creek. The best beaches are at Chamber's Station, west of Salt Lake City, where one of them is 400 feet wide (Figs. 27, 28, 29, 32).

Erosion of mountains by water produces V-shaped canyons and torrents; the faster the erosion the narrower the V. These are the most common canyons in Utah. Magnificent examples of this are the lower parts of Big Cottonwood and American Fork canyons, whose walls are nearly 4000 feet high and almost vertical; still greater is the Grand Canyon of the Colorado, nearly 6000 feet deep. The grandeur of Utah scenery depends upon this feature of erosion, combined with glacial action (Figs. 2, 5, 15, 16, 17, 19).

When continents are young they generally rise faster than they wear away; but as they get older the mountains are cut down faster and the plains expand till the former look like islands in the latter. This is the case with most of the ranges in the Great Basin. Mountains are sharp and rugged during their middle life; the younger they are the more smooth and rounded they appear. This is beautifully illustrated by the rugged and gray old Wasatch and Uintas, and the plump, rounded, and young Coal Range (Figs. 2, 6, 7, 9, 11, 14, 54).

The rapidity of erosion under favorable conditions is almost beyond belief. The material taken away from western Utah, the Wasatch, and Uintas since the Coal Age was all laid down in eastern Utah and western Wyoming over an area several hundred miles long and wide, and over a mile deep. Again, the same material south of the Uintas has been almost entirely removed, to a depth of nearly 2000 feet, over an area 200 miles long and 75 miles wide, and carried out into the Gulf of California. A peculiar feature of this latter region is that the bottom of these beds is composed of clay, which wears away faster than the overlying rocks, and thus the

weather undermined them so that there was always a precipitous face presented as the erosion crept back. This precipice of 2000 feet has worked back through the plateau toward the Uintas, and is called the Book Cliffs. It has also crept westward till it has eaten away all of the great plateau there, except a strip 15 miles wide between it and the Sevier Valley, called the Coal Range or Wasatch Plateau. The ground uncovered by the creeping back of the precipice is still a great clay bed, wasting away rapidly, and is so unsuitable to vegetation that it is a desert which yields slowly to cultivation (Figs. 4, 5, 15, 16, 19).

Thus we see that erosion has cut down the mountains, produced most stupendous changes, and is still causing destruction by cloudbursts. This is all due to the carrying power of water under favorable circumstances. We find also that deposition has filled eastern Utah with an immensity of material that is almost beyond belief, and has also taken most of it away again. We find that erosion in dry climates produces far different effects from that in wet climates.

Chemical changes take place also while rocks are being worn down, producing compounds, some of which will dissolve in water, such as the salts of magnesium, sodium, and potassium. They are usually in such minute quantities in proportion to the water in streams and springs that they are not noticeable to the taste. But in dry regions, the water collects in the valleys and evaporates, and the minerals are deposited because they do not evaporate. Therefore they soon become evident in the soil, and change or kill the vegetation. From this cause flat regions which dry up entirely become veritable deserts like that west of Great Salt Lake. In basins that do not dry up entirely the water becomes very salty in time.

Great Salt Lake is an example of this, with its water carrying twenty-five per cent of these salts, amounting to seven billions of tons, most of which is common salt.

Glaciers. — Glaciers are streams of frozen ice. They were confined to the higher mountains of Utah. Ice under heavy pressure will flow like thick molasses, but very slowly. In the heads of all the great canyons of the Wasatch and the Uintas and in isolated spots around Mount Belknap, the Deep Creek, Oquirrh, Aqui, Fish

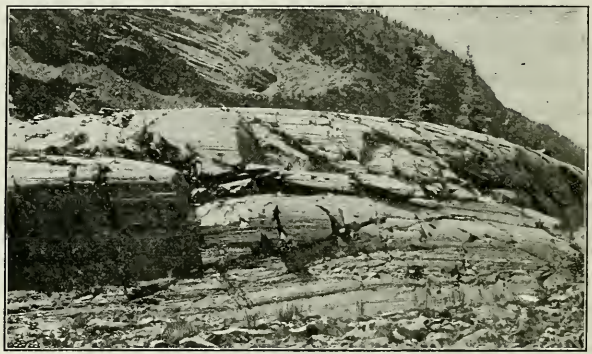

FIG. 6.

Glacier-scored rocks at Lake Blanche. This is solid bed rock, scored and polished. Alpine flowers in the crevices.

Lake, Henry and La Sal mountains, vast beds of snow collected during the Ice Age, and remained from year to year. The great weight of this mass changed the lowest snow of the beds to ice, and because of the slope forced it slowly down the canyon in a stream. This stream of ice froze to everything that it touched and either carried it away or was itself forced over it, if the obstacle was fixed immovably in the ground. Loose rocks lying on the bottom were seized and forced along, scraping and cutting

everything they passed over. The same was true of every particle of grit, however large or small, and thus the canyons were, so to speak, sand-papered out very rapidly into U-shaped slopes by the glaciers. Since the depth of the scratches would be governed by the weight of the overlying ice and snow, the heads of canyons were cut down quicker than the lower parts, which resulted in

FIG. 7.
Scoring tools at Lake Blanche. Glacial amphitheatre in the background. Firs in the centre.

the formation of pot-holes, basins, and amphitheatres there. Material falling on the top of the ice stream from the cliffs is most abundant along the edge, and is called a moraine. When a glacier flows so far that it reaches a region which is too warm for it, then the ice melts at the end as fast as it flows, and drops there all the débris that it is carrying along. The finer material will be washed off by the river which the melting glacier forms; the heavier material will be left behind in a great pile which is called a terminal moraine.

Most of the glaciers in the Wasatch and other mountains, except the Uintas, were short. Only one of them reached the valley below and furnished icebergs to float on Great Salt Lake, this was the glacier of Little Cottonwood. At the close of the Ice Age the ice streams melted faster than they flowed, and so they rapidly disappeared up the canyons, leaving a train of boulders and débris behind. There was a short time when the glaciers re-

FIG. 8.

Meadow at the north end of Fish Lake, showing the meanderings of the river. A typical grazing scene.

mained stationary and made large terminal moraines halfway up the canyons, but after that they quickly disappeared.

A dying glacier uncovers at its head all its secrets. There is no more beautiful illustration of this than around Lake Blanche. There we find great boulders lying at the ends of the grooves they have cut, as though waiting for the ice to push them along and finish their work. These parallel lines, which vary from a foot deep to the finest

hair lines, are everywhere. There are also surfaces as smooth as mirrors. Close by are the polished basins filled with crystal water and edged with alpine flowers. Here he who runs may read the story of the glacier written on the rocks (Figs. 6, 7, 8, 9, 14).

We find that glaciers have caused the great storage basins in Utah, which make irrigation throughout the season pos-

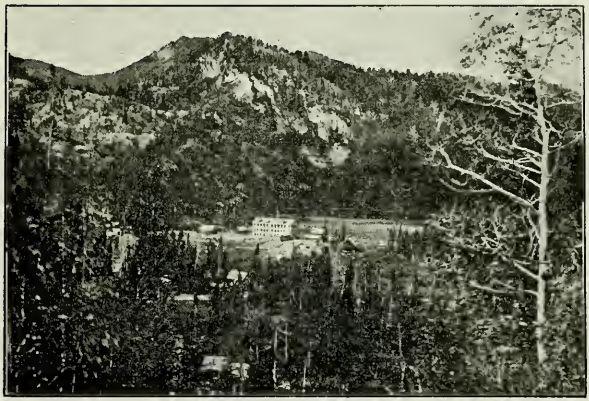

FIG. 9.

A great amphitheatre and lake at Brighton's, of glacial origin. Summer hotel in the centre. Grove of spruces with summer cottages in the opening in the foreground. Aspen tree on the right. The lofty cliff in the background is honeycombed with mining tunnels.

sible. They have also produced our beautiful alpine lakes and summer resorts (Figs. 7, 8, 9).

Snowslides. — The high winds in winter pile up great combs of snow under the crests of the mountains. Under favorable circumstances these masses, in breaking off, start the snow on the steep slopes till the whole mountain side, when destitute of trees, becomes a moving body. This increases in speed and power till stumps, trees, boul-

ders, and houses in its track are swept away and piled up in the canyon below. Thousands of men have lost their lives by snowslides, and much mining property has been destroyed (Fig. 10).

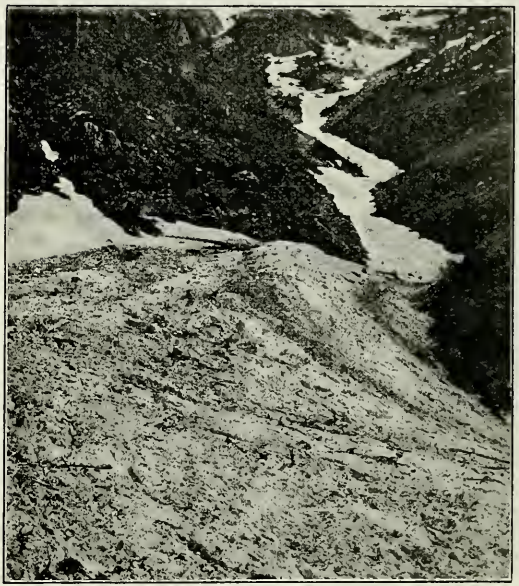

FIG. 10.

A snowslide in City Creek Canyon, which tore up everything in its way and piled up snow, logs, and stumps in the canyon below.

Wind Sculpture.—Though there is some wind sculpture in southern Utah, it reaches its perfection in southern Nevada. The rainfall there is so slight that the canyons have no streams, and are visited only by an occasional cloudburst. The débris, which is produced by the action of the sun upon the rocks, if fine, is picked up by the wind as dust, sand, or gravel and carried into the depressions, till in time they are filled so that the mountains slope gracefully into the foothills, and these pass by the most exquisite curves into the open valleys.

QUESTIONS. — What is erosion? What is deposition? Why are erosion and deposition valuable to Man? What is the chief factor in erosion? Why does the surface wear away so rapidly when the ground is first raised above the water? How much is the carrying power of water increased by doubling its velocity? What governs the speed of water? What conditions are suitable for cloudbursts, and what not? What does the selective power of water cause? What are alluvial cones? What governs the formation of deltas, etc.? Give examples of old beaches and bars. Where are the best old beaches found? What does erosion by water cause? Mention the greatest water-made canyons of Utah. Upon what does the grandeur of Utah scenery depend? What is true of young continents and what of old ones? How do young continents differ from old ones? Can you give examples? Describe the rapidity of erosion under favorable circumstances, and what it has done in eastern Utah. What fine scenery has it produced in Utah? What has it left, and what is their character? Does erosion by water cause any other changes than the wearing away of material? Where do these changes show themselves, and what do they cause? Give examples.

What are glaciers? Where were they found? To what are they due? What do they do on their way down the canyons? How can you tell a glacial canyon? Why are lakes formed at the heads of glacial canyons? What is a moraine? What do glaciers form at their lower ends? How many glaciers in the Wasatch reached the valley? What caused the death of the glaciers? When does a glacier tell her secrets? Where can you find these secrets revealed best? What are snowslides, and what are their effects? Describe wind sculpture.

SEARCH QUESTIONS. — Why does the rapidity of erosion depend on the slope, etc., and why is the carrying power so greatly increased by doubling the velocity? How can you tell whether bars were formed when the waters of the lake were rising or falling at different periods in its history? Why are young mountains smooth and rounded? Why is erosion no faster over a large area than over a smaller one in proportion? Why do not minerals evaporate as well as water? Why do we not have glaciers in Utah now? In what years are snowslides most common?

CHAPTER II

TOPOGRAPHY AND DRAINAGE

Topographically Utah is divisible into the Great Basin, Colorado River, and Snake River drainage areas. The latter is not worthy of special mention.

Great Basin Region. — *Western Utah Section.* All that part of Utah west of the Wasatch and north of Kanarra is

FIG. 11.

A typical desert valley in western Utah. The white bushes in the foreground are the winter fat, the most nourishing desert food. The dark bushes are the rabbit bush; the larger ones in the centre are junipers.

practically a plain with parallel and interrupted ranges of mountains running nearly north and south, rising out of the level ground like islands, and being about 20 miles apart (Fig. 11). The elevation is about 4600 feet above the sea. There is not a single river flowing through it and only two touch its eastern edge. All its mountains are rugged and steep, 2 to 5 miles wide at base and generally precipitous

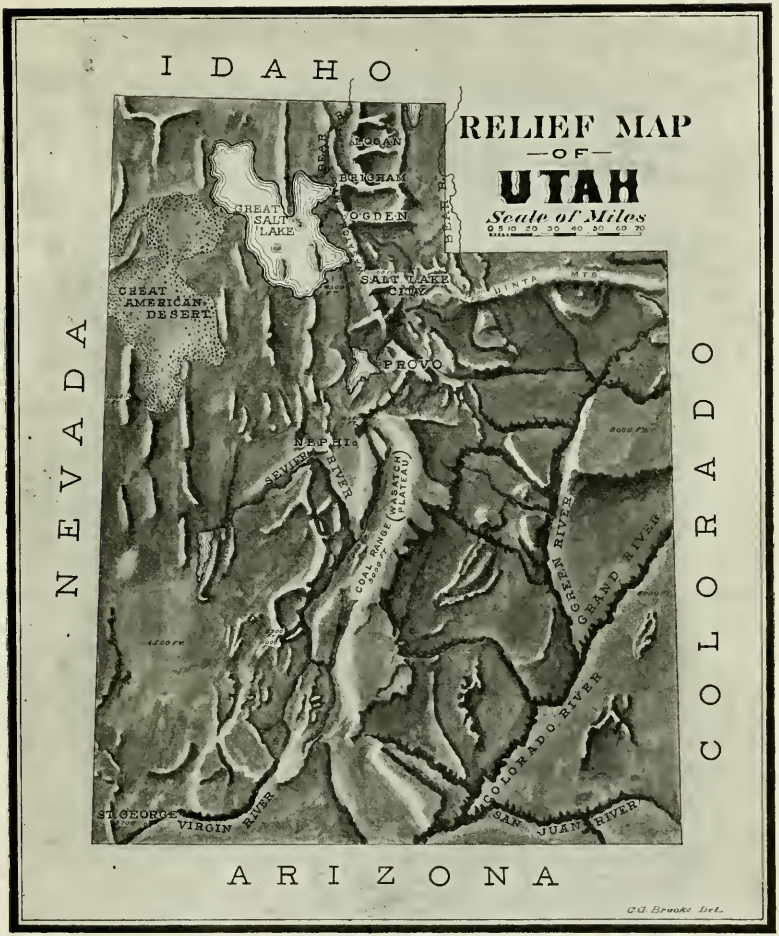

FIG. 12. facing p 22

QUESTIONS. — Locate all the lakes in Utah, principal rivers and cities. Locate all the plateaus, principal mountain ranges, regions with deep canyons. Trace the Great Basin Divide in Utah. Describe the general relief of the state. Give the principal elevations. Make a clay model of the relief of your county.

on one side. They average about 4000 feet at tip above the plain and are scored by deep canyons. Few have snow later than June, and for the most part even these have no streams that reach the plain below after that date. All have scattered springs in the canyons.

The Oquirrh and Aqui mountains have short ridges which rise to nearly 11,000 feet above the level of the sea. The Deep Creek Mountains and their extension, the Snake Valley range, are still loftier, and, like others, carry snow in July, have several living streams, and support a few settlements. The mountain ranges are covered with sagebrush and are scantily clad below with junipers, piñons or oaks. Only on the highest parts is there any timber. All contain valuable minerals. The rocks in this region consist chiefly of limestone or quartzite. Now and then there is granite or other eruptive rock.

The plain is covered with sagebrush or alkali-loving plants, except an area 40 by 100 miles, west of Great Salt Lake, which is an absolute desert. Scattered over the general Utah plain are isolated alkaline lakes, which were once connected with Great Salt Lake. The most important agricultural areas in this region are Tooele, Deep Creek, and Skull valleys, and a fertile region lying on the edge of the desert from Leamington to Kanarra.

The Wasatch region, with its southern extension west of Sevier Valley, is the backbone of Utah from every economic standpoint. The mountains rise precipitously on the west about 7000 feet above the plain. They are picturesque and grand, and are cut completely through by the Bear, Ogden, Weber, Provo, and Sevier rivers. They are deeply carved by glacial canyons and taper into towering ridges (Figs. 2, 7, 9, 10, 45). Toward

the base the mountains are covered with oak brush (Fig. 34), and higher up they are, in patches, heavily timbered. The canyons are well watered by clear, cold, and living streams, which have sufficient volume and fall to furnish all the power required in the valleys below. These streams are the life of the valleys at the foot of the mountains, and support a dense population which is grouped in many cities and towns from Cache to Sevier Valley. The mountains carry snow during the entire year.

North of Nephi the most productive valleys are on the west, but south of that they are at the east of the mountains. Though there is a fringe of cottonwoods along the streams, the valleys are without timber, except where trees are planted and irrigated. (For illustrations of valley scenery see Figs. 47, 49, 51, 52, 53.)

Cache is the largest valley on the north, being thirty by ten miles. It slopes toward the centre, where the Bear River cuts it, and its elevation is about 5000 feet. It is surrounded by mountains, except on the northwest (Fig. 51). The principal streams are Blacksmith's Fork, Logan, and Little Bear rivers, in addition to the Bear.

Lakeshore is a long strip of fine land from Salt Lake Valley to Collinston, which at the north expands into a large area around Corinne. It is walled in on the east by the Wasatch. The slope is gentle toward the west, the elevation is about 4300 feet above the sea. It is watered by the Bear, Ogden, and Weber rivers, and by many streams (Fig. 52).

Salt Lake Valley has a similar elevation and situation to that of Lakeshore, but is bounded on the west by the Oquirrh Mountains, and is cut off on the north by a spur

from the Wasatch. It is eighteen by ten miles and slopes gently to the north; is abundantly watered by the Jordan River and by streams from the Wasatch, and is the most populous valley (Figs. 47, 53).

Utah Valley is cut off from Salt Lake Valley by another low spur from the Wasatch. It is half-moon shaped. In the centre is the beautiful Utah Lake, covering 130 square miles; it abounds with fish, is a summer resort, and in winter has fine skating. The land, which slopes gently toward the lake, forms a strip about 40 miles long. Its average width is about 5 miles. The elevation is 4500 feet. It is watered by the Spanish Fork and Provo rivers, and by American Fork, Hobble Creek, and other streams (Figs. 49, 50). Goshen Valley, lying on the southern side of the lake and watered by Salt Creek, is really a part of this valley.

Juab is a little scantily watered valley, lying under the shadow of Mount Nebo, south of Utah Valley, with an elevation of 5500.

East of the Wasatch the valleys at the north are few. The largest is Bear River Valley, lying in the corner of the state, heading in the Uintas, and ending near Soda Springs, Idaho. It is about a hundred miles long. It is narrow, high, and cold. On the east of this the Great Basin Divide rises in high and rolling hills, running from the Uintas toward the Tetons and thence turning abruptly to the Wasatch.

Ogden Valley is a small mountain-locked region lying east of Ogden.

Weber Valley is a narrow and crooked region bordering the Weber River and having enlargements at Morgan, Henefer, Coalville, and Kamas. It is nearly 60 miles

long and runs from 5500 to 7000 feet elevation. It is watered by several small streams.

Parley's Park is properly a branch of Weber Valley. It is nearly round, about 10 miles long, and is somewhat cut up by hills. It lies at the foot and on the east of the Wasatch, with an open country beyond, and has an elevation of about 7000 feet. It is snowy and cold in winter.

Provo Valley belongs to the same general region as Parley's Park, but is lower. It is three-cornered, about twenty miles long, nestling among the mountains, and like Parley's Park, is cold and snowy in the winter.

At the upper end of Provo Valley begins the Great Basin Divide, south of the Uintas. It runs nearly due south in a uniform swell or plateau about 9000 feet above the sea to Manti, where it turns more to the southwest, and continues to opposite Panguitch, a distance of about 175 miles from the Uintas. Thence it turns west to Kanarra, maintaining its great elevation. This is the Coal Range or Wasatch Plateau. It, with the Book Cliffs, furnishes nearly all the coal used in Utah. It is also heavily timbered in places along its crest, particularly at the south (Figs. 43, 19).

Nestling between the Wasatch and the Coal Range opposite Utah Valley is Thistle Valley, with a north slope, triangular outline about 10 miles long, and an elevation of 6000 feet. It is cold and snowy in the winter. Thistle Valley is an Indian reservation.

Sanpete Valley lies over a rolling divide just south of Thistle Valley and is 50 miles long, 15 miles wide in the centre, and tapers at both ends. The elevation is about 6000 feet. It runs north and south, has a southern slope, and is well watered by streams from the Coal

Range. Like Cache Valley it is rather cold in the winter.

Region south of the Wasatch. — Sevier Valley joins the southern end of the Sanpete, runs west into the Sevier desert and also south about 125 miles to the head of the Sevier. It is from three to ten miles wide, slopes to the north and lies like a long arm west of the Coal Range. Though the largest valley in Utah, it is not so well watered as some of the others. The Sevier River furnishes most of its water, though part comes from Clear, Beaver, Bullion, Cottonwood, Salina, and Lost creeks. The San Pitch also furnishes water. At the upper end it is snowy and cold, heavily timbered, and 7000 to 8000 feet in elevation; but at the north it is warmer, without forests, and about 5000 feet above the sea. There is more clay in the soil than usual.

Grass Valley is a branch of the Sevier east of Junction, where the east fork of this river cuts through the mountains, and branches into north and south streams. These drain the valley, which is about 40 miles long, is high and cold, and lies under the edge of the Coal Range.

There are other small valleys in the Great Basin region, such as Gooseberry, Dog, and Round valleys.

We find that Utah is divided into two grand drainage areas, the Great Basin and the Colorado River region (Fig. 12). *The Great Basin is a large plain with island-like and interrupted ranges of mountains. It is very dry and barren in the west, but close to the Wasatch is well watered and very fertile.*

Colorado River Drainage. — The most conspicuous features outside of the Great Basin in the Colorado River drainage are the Uinta Mountains and the Grand Canyon

of the Colorado. The Uintas are about a hundred miles long, are nearly 14,000 feet above the sea, and are better watered and timbered than the Wasatch, but the streams have worn such deep canyons that it is only occasionally that they are available for irrigation, and so the region is noticeable chiefly for its timber, grazing, and scenery. For a view of the west end of the Uintas, see Fig. 14.

FIG. 14.

Beaver Lake at the head of the Weber on the western end of the Uintas. Reed's Peak in the background. Alpine willows on the edge of the lake. The water is full of trout.

The Navajo Basin is the name given to the region south of the Uintas and east of the Coal Range. Except at the foot of the cliffs and in the Duchesne Valley and Strawberry Valley its western extension there is a succession of dry mesas and deep canyons with very poor soil; the farther south, the higher are the mesas and the deeper are the canyons (Figs. 15, 16).

Just south of and parallel to the Uintas runs the *Duchesne Valley*, which is watered from the mountains and is quite productive. Some distance south of this is the Minnie Maude Creek with a few ranches. Near the

base of the Book Cliffs flows the *Price River*, which has several small towns below Helper. Along the foot of the Coal Range several streams come out at intervals and have settlements along them. Still farther south, at the head of the Fremont River, is the nearly round *Rabbit Valley*. Along this river, but farther down, are several small settlements. In the midst of the desert region east of Rabbit Valley rise the dome-like *Henry Mountains*,

FIG. 15.

Scene in the canyon of the Virgin River above Springdale. The rocks are highly colored sandstones, and tower 2000 feet in the air. The desert cottonwood on the left.

clad at the top with timber; but their water supply is too small to support towns. Where the Green River comes through the *Book Cliffs* there is a good-sized tract of clay land, in which fine crops are raised, especially cotton, but the river soon enters the canyon below, and the arable land ceases. On the Grand River near the La Sal Mountains is *Little Grand Valley*, a gorge in red sandstone mountains, coming down from the La Sals. It is admirably adapted to fruit. The lofty La Sal Mountains, which are simply volcanic peaks, support

many ranches, and have some timber. South of this region rise the Blue or the Abajo Mountains, which are also volcanic peaks, whose short streams support few ranches. Near the southeastern corner of Utah is the *San Juan River*, supporting the town of Bluff. This is located on a narrow strip along the river. In this region the rivers all enter canyons. At about the southern end of the Coal Range on the head of the *Pahria* are a few

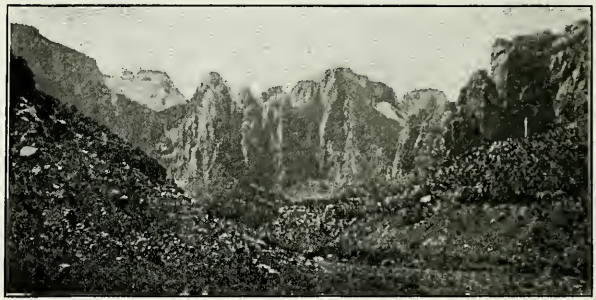

FIG. 16.

An alcove canyon on the Virgin River. Variegated sandstone in the background. Junipers on the slopes at the right.

settlements. The narrow valleys are cut deeply into the plateaus.

After the range turns westward there is a great plateau at the foot of it, extending south to the Colorado. It is without water except in a few places where the canyons empty into it from the Coal Range above. In one of these canyons is Johnson and in another is Kanab. The *Virgin River*, which heads in the Coal Range and flows westward in a narrow valley, has several knots of settlements. Then it drops over the red sandstones into a box canyon. This gorge continues down to near Springdale (Figs. 15, 16,

48). From this place to Nevada the river lies deep in the plateau, but here and there its valley widens out into arable tracts, and narrows again into canyons below. The elevation is from 3000 to 2700 feet above the sea. The climate is very warm and tropical. North of St. George rise the *Pine Valley Mountains*. This is a short but steep range, which has a few streams supporting small towns.

We find that the Colorado River drainage is in the main a region of great canyons and barren mesas, with poor soil. It is a large coal and oil section. In the south a tropical climate prevails and fine fruit is raised.

QUESTIONS. — Describe the topography of the Great Basin and trace its boundary line. What is the elevation of the plain? What is the elevation of the mountain peaks as a whole? What mountains have snow throughout the year in protected spots? Do any have their peaks covered all the year? What are the most important mountains? What is the vegetation of the plains? Describe each mountain range. Describe each valley. What are the most common rocks? Name the principal rivers and describe their courses. What are the sources of these rivers? What is the vegetation of the mountains? Is there any timber and where? Name the cold valleys. What is the Navajo Basin? Describe it. Give its rivers and boundaries, valleys, mountains, and principal canyons.

SEARCH QUESTIONS. — Why is the Great Basin a great plain? (See *Geological History.*) Why are the Wasatch valleys so well watered? How do we know that the alkaline lakes of the Great Basin were mostly a part of Great Salt Lake? Why is the Wasatch region the backbone of Utah? Why are the sections south of Nephi less productive than those north of it? Why does Salt Lake Valley have the most rainfall of all the low valleys except the Lakeshore region? Why do the mountains have more rainfall than the valleys? Why are many of the rivers and streams smaller at their mouths than above? Why is not the Uinta region the best in the state? In what valley or region do you live? Describe its topography, streams, and mountains.

Scenery. — Utah is a region of beetling cliffs, bare rocks, deep canyons, roaring torrents, few lakes, and few rivers. In the East the dull air covers all with a haze at short distances, making small things seem great. Here the clear air gives snap and life even to far-away mountains and thus appears to bring all things near, dwarfing the great mountains into seeming hills.

FIG. 17.

Bridal Veil Fall above Marysvale. Fir forests above. Ferns and mosses growing in the spray. Dense tufts of Heucheras on the rocks. Slender snowberry bushes below. These are quartzite rocks.

In our valleys the finer than Italian sunsets are a constant source of delight. The snowcapped mountains, often cutting the clouds, and their endless changes are a perpetual inspiration. From the foothills adjoining the towns magnificent views of the valleys are obtained. From the tops of the highest mountains the panorama of the populated portion of Utah may be seen for 200 miles in one direction and 100 in another. The mouths of the Wasatch canyons are magnificent because of their narrowness and the depth to which they are cut. Here the streams break into torrents, cascades, and waterfalls, and the canyons open up into innumerable recesses 4000

feet high. American Fork and Big Cottonwood are the grandest of these canyons (Fig. 45).

In southern Utah, along the middle Virgin River, the attractiveness of the views is heightened by the gorgeous coloring of the rocks. Similar scenery is found at Castle Gate, Capitol Wash, and along the Green and Grand rivers. The most magnificent of all views are found along the Colorado (Figs. 15, 16, 19).

FIG. 18.
Waterfall below Lake Minnie, tumbling over glacial rocks.

On the Green River Desert toward Cisco there are many clay mesas, which have been worn into the most remarkable sculpture by rain (Fig. 4).

On the Fremont River is a great variety of desert scenery, due to the alternating colors of the soft clay and sand beds.

In the higher parts of the Wasatch and Uintas the canyons open out into great glacial amphitheatres, which are from 9000 to 10,000 feet in altitude above the sea. Their walls rise 2000 feet vertically above them, and the peaks 1000 feet still higher than the walls. These amphitheatres are studded with alpine lakes, gorgeous meadows, and open forests (Figs. 7, 9). These are the storehouses of the winter's snow, and thus make irrigation pos-

sible at a time when the crops are drying up in the valleys below.

Here the flora reaches its perfection. There is to be found a remarkable number of brilliant flowers, so that the whole country is a mass of color. Some 1100 species of flowers grow in the higher Wasatch. Meadows carpeted with moss, grass, and bright flowers border the lakes or fill up their old beds. The ice-cold springs and rivulets are half concealed by drooping blue-bells, mimulus, columbines, and asters. The glacier-worn rocks are spattered with brilliant lichens, and the cracks are filled with rich sedums, asters, and pentstemons. Here and there are beautiful patches of spruces and firs, affording shelter and shade for the tents of campers. Not far off, under the cliffs, are patches of snow that never melt, though having their fringe of alpine flowers.

The summer climate is so cool and delightful here that many places in the Wasatch are used as summer resorts. The most noted are Brighton's, American Fork, Lake Blanche, in the Wasatch; the sources of the Bear and Weber, in the Uintas; and Fish Lake and Bullion canyons, on the Sevier (see Figs. 8, 17). Other resorts are Bear and Panguitch lakes, Parley's, Ogden, and Blacksmith's Fork canyons.

We find the scenery of Utah differs widely from that of of the East. Utah is a region of bare rocks, towering mountains, great canyons, and beautiful mountain lakes. There are brilliant mountain flowers in great variety. Utah has all kinds of climates. The country is mostly covered with sagebrush and is without a sod.

QUESTIONS. — How does Utah differ in scenery from the East? Can a person get an extended view anywhere in Utah? The horizon

on the prairie states is about six miles in diameter, is there any such place in Utah? If so, where? What is the scenery of the mountains? Describe that along the Virgin River. What is peculiar to the Green River region? For what are the higher parts of the Wasatch and Uintas noted? How many kinds of flowers are known in the high mountains? Why do people go the mountains in summer?

Search Questions. — What causes the beautiful sunsets? Why does not the snow melt first on the mountain tops as they are nearest the sun? Are alpine lakes more valuable as reservoirs than valley lakes? If so, why?

CHAPTER III

MINERAL RESOURCES

Mineral Resources. — The mineral resources of Utah are the greatest of any, and upon them depends a large population (Fig. 12).

For convenience we shall group the minerals into those which are not found in veins, that were caused by eruptive rock, and those which are found in veins caused by such rock.

Minerals not found in Veins caused by Eruptive Rock. — This group may again be divided into those having their origin through eruptive rock and those deposited in connection with water.

Minerals of eruptive origin are pumice, sulphur, and building stone.

Pumice is an eruptive rock, thrown out by a volcano, and is so full of cavities that it is lighter than water. Our best pumice deposits are in Millard County.

Sulphur is found in the vents of old volcanoes, where it has collected from fumes which have come up through the loose material below. To be purified it is put in iron cylinders and steam is forced through. This melts the sulphur so that it runs out. The largest deposits are at Cove Creek, near Milford and at the head of the Bear.

The *building stone* of volcanic origin is granite and basalt. The finest granite is in the Wasatch and covers an area of five square miles. The Salt Lake Temple is built of this granite.

Basalt is the chief building stone of southern Utah. The St. George Temple is made of it (Fig. 48).

Minerals deposited in Connection with Water. — The chief minerals of value in this group are coal, petroleum, building stone, gypsum, salt, travertine, marble, tripoli, etc.

Coal is the most valuable of these products. It is derived from beds of vegetable matter which were originally peat bogs. Our coal is of three kinds, soft lignite, hard

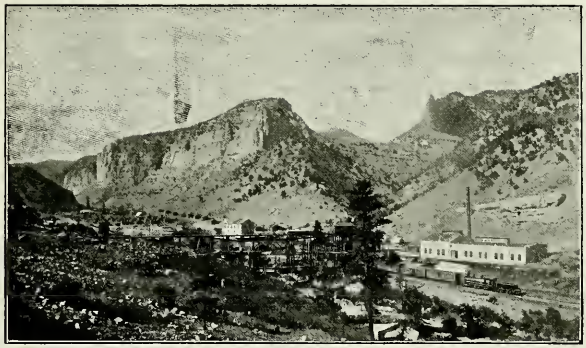

FIG. 19.

Castle Gate coal mine, with trestle. Power house and railroad on the right. Houses of miners in middle ground on the left. The coal vein lies just over the rocks that appear behind the smokestack.

lignite, and anthracite-graphite. There are a few narrow beds of soft lignite near the Aqui mountains, near Wales, and a few places in eastern Utah: only the Wales beds have any value. The hard lignite forms nearly our entire coal supply. It underlies the Coal Range, the Book Cliffs, and the region around Coalville. It belongs to the Utah Coal Age (Cretaceous). The coal veins lie nearly flat at the eastern edge of the Coal Range and in the Book Cliffs, and therefore are worked by tunnels, but at

Coalville and on the western edge of the Coal Range, the beds dip rather steeply and are worked by inclines. Inclines are made like tunnels, but they pitch down sharply. There are several beds of coal lying one above another through the strata of this age. Those deposits which are worked run from 3 to 40 feet thick. The thickest ones are found from Scofield to Salina Canyon. There are over

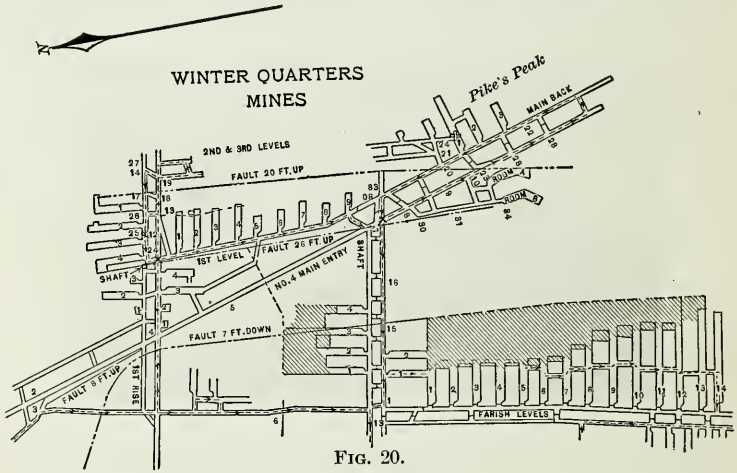

FIG. 20.

Section of Winter Quarters coal mine, near Scofield, showing the way in which the coal is mined.

7,000 square miles of coal lands in Utah. Therefore, the coal is valuable only according to its nearness to some railroad.

Our coal is black, breaks in cubes, produces much smoke, and carries from one to three per cent ash. It was discovered very early in Utah at Cedar City and Coalville. The annual production is now about 1,500,000 tons, valued at $2,000,000. Fifty-five thousand tons of coke are made. The method of mining the coal is illustrated in the dia-

gram of the Winter Quarters coal mine (Fig. 20). Most of the work is done by hand, and the ground is allowed to cave after the coal is taken out. Coke is made from the fine coal that passes through the screens which are used to sort the coal. This stuff is carried to a group of ovens and set on fire. After a certain period the air is shut off, and the coal turns to coke. Fig. 21 shows the

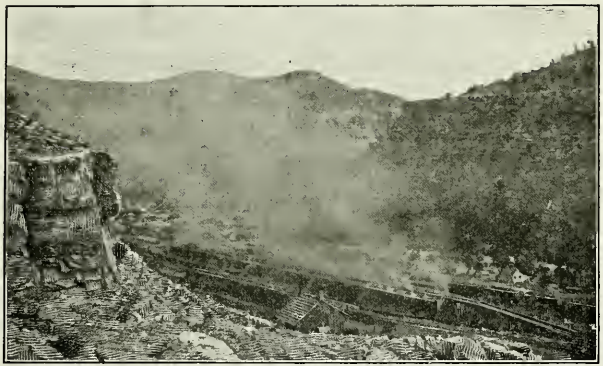

FIG. 21.

Castle Gate coke ovens with track in the centre for dumping the coal into the ovens. Each white spot on the top represents an oven.

Castle Gate coke ovens. Fig. 19 shows the outside works of the same mine.

In many places the edges of the coal beds are exposed to the air and the coal has taken fire. After it has burned back for some distance, the overlying rock has caved and shut off the air from the burning coal, and thus produced a natural coke. Examples of this are found in Spring Glen, the Henry Mountains, and near Pine Valley. In the Scofield region porphyry dykes have accomplished the same thing in the coal veins. Anthracite-graphite beds are

found only in the blue limestone of the Wasatch, and belong to the true Coal Age. The largest beds are found high in the mountains from Mill Creek to Payson. Near Provo is a bed about four feet thick. The coal burns freely without smoke, but contains a large percentage of ash. This coal is found in the precipitous cliffs back of Provo (Fig. 50).

Petroleum, Natural Gas, etc.—Where vegetable and animal matter have been deposited in beds in the presence of salt water and afterwards covered with a great thickness of rock, petroleum and natural gas are formed by a slow process of natural distillation somewhat after the fashion of the production of tar from a charcoal pit. If the beds in which these are deposited are tilted up like the roof of a house, gas and oil collect in large quantities; but when the beds lie flat they collect in smaller quantities. Nearly the whole of Utah east of the Coal Range is underlaid by oil and gas strata. The region from Salt Lake City to Collinston is also underlaid by oil and gas strata. The region around Colton has many cracks which have been filled with ozokerite, a kind of paraffine. Other cracks in the vicinity of Emma's Park have been filled with an asphalt containing paraffine, and is called Wurtzellite. In the Ashley region still larger cracks have been filled with a black, shining asphalt called gilsonite. All these are the products of petroleum, which has collected in the rocks and partly evaporated.

Building Stone.—The most common and easily worked rock in Utah comes from the sandstone beds. The best quarries are found near Fort Douglas, Parley's Park, near Thistle, Kyune, Echo Canyon, and in southern Utah (Figs. 3, 15, 16, 19). The *Deseret News* building and the City

and County Building in Salt Lake City are made of these sandstones. The finest shell limestone comes from near Logan. Quartzites are much used for flagstones because of their hardness. Among the ornamental stones used for building, the Sanpete oölite stands first. It is easily cut with a saw, but hardens on exposure. It abounds from near Fairview to Salina. The Manti Temple is made of it.

One of the most beautiful stones is the *Mexican onyx* or *travertine*, which is a pure marble deposited in bands at springs. On being cut and polished this becomes very beautiful because of its colors. This rock is found in many places in Utah, especially at Pelican Point, American Fork Canyon, Redmond, Salina, etc. The City and County Building at Salt Lake City is ornamented with it. Marble is found at Santaquin, also in western Utah, and a black variety occurs near Pelican Point.

Gypsum. — This is found in large beds, often twenty feet thick and quite pure, at Nephi and Salina. It also occurs in very pure crystals in the Henry Mountain region, and in fine layers near Parowan. This becomes plaster of Paris when heated until the water is driven off.

Salt. — Associated with the gypsum are extensive beds of salt, which occur from Nephi to Salina. Most of it is mixed with red clay, but pure spots are found. This salt is much used in large chunks for stock. It is also dissolved and evaporated for dairy salt. About 90 per cent of the solid matter of Great Salt Lake is salt. This water is pumped from the lake into ponds. The salt is collected in the fall after most of the water has evaporated. The product is about 40,000 tons a year.

Tripoli. — Tripoli is a polishing powder which is found

around old springs in the Salt Lake desert and north of Great Salt Lake.

Portland cement rock, plastering sand, fire clay, brick clay, ochre, and nitre are found in Utah in commercial quantities.

We find that the most valuable mineral deposited in connection with water formations is coal, and we find that graphite and anthracite are only modifications of it. There are great bodies of coal in Utah. There are many kinds of building stone which are suitable for all purposes. Salt and gypsum occur in great quantities.

Questions. — What are the valuable minerals having a volcanic origin? What is their use? Where found? How is sulphur purified? Of what is the Salt Lake Temple made? The St. George Temple? What is the chief mineral deposited in connection with water? Of what kinds? Where found? What is its extent? Where is anthracite-graphite found? What is its character? How is petroleum formed? Where is it found? Where is natural gas found? What other products belong to the petroleum group of minerals? Where are they found? What is the most common building stone? Where found? What other kinds of building stone have we, and where are they found? What do you know about travertine in Utah? Gypsum? Salt? Tripoli?

Search Questions. — For what is pumice used? What is made out of sulphur? Do sheepmen use it, and why? What causes the sulphur fumes in volcanoes? How does granite differ from basalt or lava? How is coal mined? How is coke made? For what are petroleum and natural gas used? Gilsonite? Ozokerite? Of what is the Sanpete oölite made? What causes the bands in travertine? Why is the clay red that is associated with rock salt? For what is tripoli used?

Minerals deposited in Veins. — There are many minerals and compounds of minerals in this class, but the chief ones are gold, silver, lead, copper, zinc, and iron. Since

the same general law applies to the origin of all these in the rocks, they are treated together.

It is necessary, in order to have a deposit of ore, that there be near it a body of porphyry; for the fissuring or splitting of the rocks and the filling of the cracks so formed is the cause of the deposits of minerals. When melted rock is forced into fissures in other cold rocks, the water, which is everywhere present below the surface, is heated, as well as the rocks, and rises in the fissures or adjoining cracks much as water does in the centre of a boiling pot. The heat makes chemical changes in the rocks and produces sulphuric and other acids, which dissolve in the water as it passes by and circulate with it. This acid water readily dissolves nearly all metals and many other minerals over which it flows, and carries them along with it. On coming nearer to the surface, and being therefore farther away from the heated rocks, the water becomes cooler, or passes over alkalies which neutralize or "kill" the acids. This causes the minerals to crystallize out of the water along the walls, and in time they fill up the cracks and fissures with ore. This ore is a compound of various metals and sulphur. (To see how minerals which have been dissolved in hot water crystallize, throw alum in a small quantity of hot water till the water will dissolve no more. Be sure to keep the water boiling all the time; then pour it out into another dish and let it cool. The dish will soon be covered with crystals of alum.)

Afterward the movements of the earth's crust often raise the mountains so much higher that the water drains out of the upper part of the veins. Then the surface water from rains and melting snow trickles down along the cracks and rusts the ores because the water carries oxygen and carbonic acid, which take the place of the sulphur in the ores. Since it does not take as much oxygen and carbon as it does sulphur to make compounds with the metals, rusted ores will contain more metal to the ton than unrusted ores, and so will be more valuable. It is also true that oxygen and carbon do not cling so closely to the metals as sulphur does (that is, the chemical compounds are more easily broken up). For this reason rusted ores are more easily treated to get the metals out of them. The value of ore depends upon the amount of metal in it, and the cheapness of getting it out in a metallic state. So we see why rusted

ores are near the surface and are usually more valuable than those lower down which are not rusted. Ores carrying sulphur, zinc, arsenic, and the like are called base ores; those carrying quartz in large quantities are called dry ores if they do not carry lead.

Quartz, heavy spar, and lime are also dissolved by these acid waters and deposited in the veins along with the ores. The cracks and fissures are not always filled with ore and the ore bodies are generally not continuous, but are found scattered in what are called chutes, chimneys, bug-holes, bonanzas, etc., according to their shape and size. Sometimes an ore body is not so large as a hand; at other times it is larger than great buildings; sometimes it is worth only cents, and sometimes millions of dollars. Generally ore bodies are connected with each other much like a string of sausages. Their shape is governed by the regularity of the fissures or cracks in which they are found, and by the ease with which the rocks adjoining them will dissolve. Since limestone carrying magnesia will dissolve very readily, ore bodies in lime take all sorts of fantastic shapes, but porphyry, granite, quartzite, and the like have more regular ore bodies because they dissolve but little. The metals are rarely found in the pure state. Therefore, ores have to be treated by special methods to get the metals out of them. There are three ways of doing this, leaching, milling, and smelting. In leaching, water is used in connection with acids or other substances which will dissolve the metals; in milling, quicksilver alone or with acids is used to hold the metals without dissolving them; in smelting, the ores are melted in smelters and certain changes are made so as to secure the metals.

We find that veins of the precious metals are always found in connection with porphery dykes, because the heat from the intruded eruptive rock is required to cause the collection of the minerals in the veins. We find that veins are generally richer near the surface because they have been oxidized or rusted, and that ore bodies which have pay values are not continuous but occur in spots. We find that the metals rarely occur in the metallic state, but have to be treated to make them valuable.

Mining.—Mining is done either through tunnels or shafts. If the country is steep, tunnels are driven into the hills; if the ground does not slope sharply, shafts are sunk. Tunnels are generally made 4 feet wide and 6 feet high, and are driven in on a level or with a gentle upward slope sufficient to make the loaded cars run smoothly as they come out on the track which is laid along the bottom of the tunnel. Small shafts are usually the

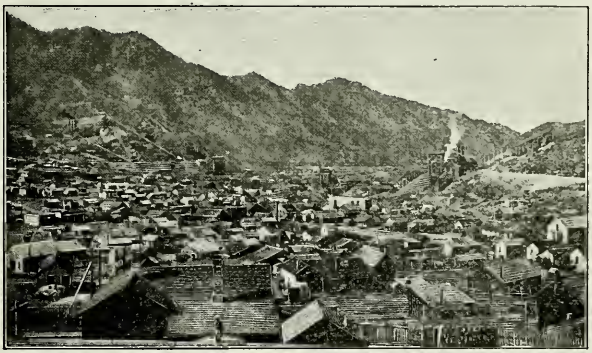

FIG. 22.

Eureka, a typical mining camp. On the right are the hoisting works of the Gemini mine. On the left is the Eureka Hill mine.

same size as tunnels, but run vertically instead of horizontally. Out of these the rock is hoisted by a windlass, whip, whim, or other hoisting machinery. When the "prospect" (which is the name given to a claim before much work is done upon it) becomes a mine, the shaft is generally enlarged and divided into compartments. It is timbered up all around to prevent pieces of rock from falling on the heads of the workmen below. Every hundred feet down the shaft, levels like tunnels are driven out

from it to the vein. Ore is carried out through them to the shaft (Fig. 25). The tools used in mining are picks, shovels, drills, gads, hammers, spoons, blasting powder, caps, and fuse. Figure 24 shows a typical prospecting rig. Mines are shown in Figs. 22, 23, 24, 25.

Mining is a dangerous business and men are paid high wages because of the risk they run.

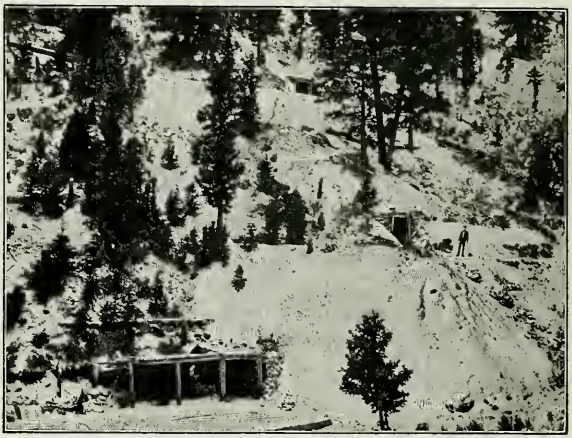

FIG. 23.

A typical mine in western Utah, which is opened by tunnels. Notice the dump in front of each tunnel. The blacksmith shop is built into the hill as a protection against snow-slides. The trees are firs.

Sorting, Assaying, and Sampling.— The ores as they come out of the mine generally have to be picked over or sorted so as to get the valuable parts free from the waste. They are then assayed to find out their values. When ores are shipped and sold they have to be sampled. This is done by taking a certain proportion, so as to get a correct average, and then assaying the samples thus obtained.

Smelting.— This consists in converting the ore into a fluid by heat, and mixing it in such a way that the silver, lead, gold, and copper will be reduced to the metallic state, settle to the bottom, and be

drawn off as bullion separate from the melted rock which is called slag. The principal smelters are the Germania, consuming about 1000 tons of ore per day; the Bingham Consolidated, using 450 tons a day, and the Highland Boy Copper smelter, which produces about 10,000,000 pounds of copper a year.

Smelting is also a dangerous business, because of the fumes that arise from the furnaces.

FIG. 24.

The regular hoist used on a prospect before it becomes a mine.

Roasting. — Many ores contain sulphur, which is injurious to the smelting and milling processes. Such ores are put in a furnace and heated till they will not quite melt, but will allow the sulphur to be driven off in fumes. This is an artificial method of rusting the ores.

Concentrating. — This is a process used to separate the particles of ore from the rock when the former are too small to be separated by hand. The methods now in use depend on the fact that the metals and most of their compounds (so far as those mentioned are concerned) are much heavier than the rock with which they are mixed,

and so can be separated from it if they are crushed to a uniform fineness, and dropped into a stream of water which is made to flow over

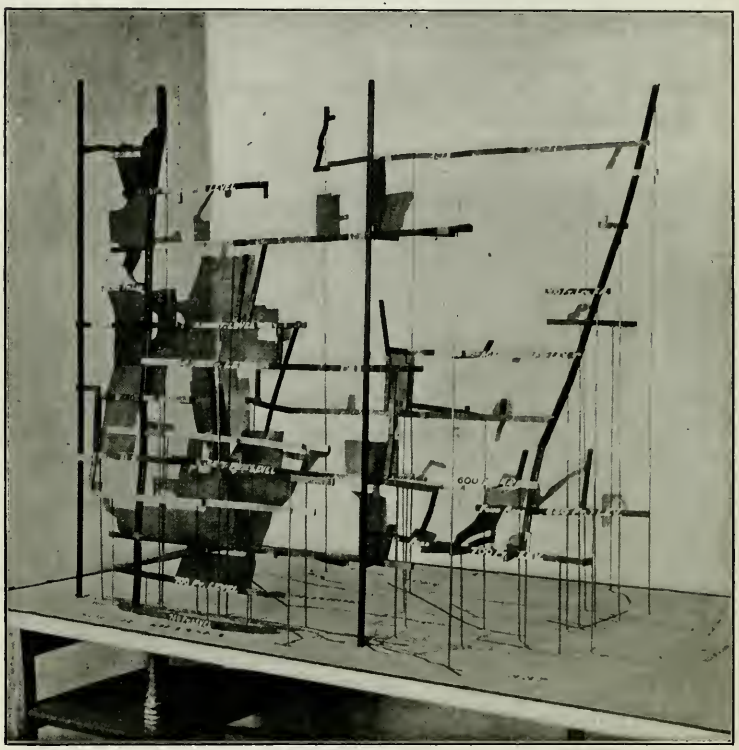

Fig. 25.

Vertical section of the South Swansea mine, showing the shafts, levels, etc.

a shaking table. Sometimes ore is concentrated by a blast of air blowing through a series of screens.

Mills. — Mills are used to separate metals from their ores and from rocks by crushing and then putting them in acids or other substances which will dissolve or catch the metals without dissolving the other minerals in the ores (Fig. 26).

Mining Camps: *Bingham.* — This was the earliest camp opened in Utah. Silver was found in 1857. Lead was first discovered at Bingham in 1863, but the next year it was also found at Alta. The first ore came from the Old Jordan at Bingham. In this camp the principal series of veins runs in an arc of a circle through the mountains from the Dalton and Lark past the Old Jordan. In at least one of these veins the ore has been continuous for over a mile and to a depth of over 1000 feet. It is mostly lead, carrying silver and some gold.

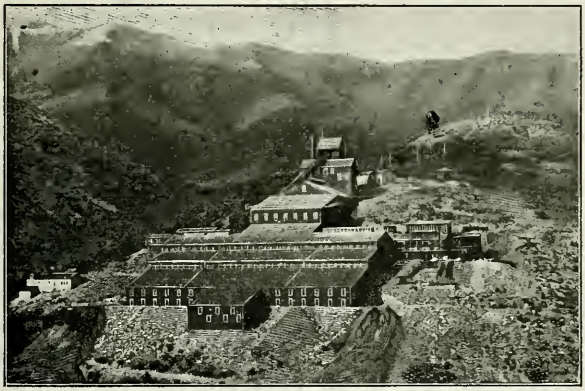

FIG. 26.

Mercur Consolidated mill. Oak brush on the hills.

Near the Old Jordan and Telegraph mines some of the ore bodies have been very wide. In late years copper has begun to show itself in the ores as greater depth has been reached in the mines. Adjoining the Old Jordan lead vein is a very wide vein of gold-bearing quartz, which is being extensively worked. From this quartz doubtless came much of the placer gold once mined in Bingham Canyon. On the north of the Old Jordan the mineral-bearing region widens or splits, so that there are a number of mines widely separated from one another. On the main vein the principal mines are the Old Jordan-Niagara, Spanish, Old Telegraph, Yosemite, and Dalton and Lark, To the north of the Old Jordan and the east are the Bingham Consolidated and Highland Boy mines. Mines located on other veins are

found scattered over lower Bingham; among these is the Tiewaukee.

Stockton and *Ophir* are old and famous mining camps which have produced much lead and silver ore. They lie between Bingham and Mercur, but on the western side of the Oquirrhs.

Mercur. — This is an old camp, which was once unsuccessfully worked for silver ores. In recent years the great veins of very low-grade gold ore, which formerly could not be worked successfully, have been made to pay by the use of the cyanide process. The veins lie nearly flat, in an arc of a circle. The ore is in lime in connection with a porphyry dyke. The veins are opened for a distance of about two miles, and are composed of broken pieces of limestone, over the surface of which a film of gold has been deposited. They also carry considerable mercury and arsenic in places. This ore is broken down much the same as a gravel bank would be, and is carried out and dumped into huge tanks, into which water carrying cyanide of potash is led. This dissolves the gold.

The principal mines in this camp are the Mercur Consolidated and Sacramento. They handle about 400,000 tons of ore a year. The Mercur Consolidated mine has about 1,000,000 tons of ore assaying $6 in gold to the ton. The cost of reduction is $3, and the product is about 1000 tons a day. The same vein occurs on the other side of the mountain, at Sunshine and the West Dip, but as yet no great amount of gold has been produced there. Mercur is a town of about 2500 people, and is snugly situated in a little gulch. It has one church, the great De Lamar, Sacramento, and Geyser-Marion mills. It is reached by the Mercur Railroad from Fairfield (Fig. 26).

Tintic. — This is the name given to the region which embraces Eureka, Mammoth, Silver City, and Diamond. It lies nearly south of Mercur in what are called the Tintic Mountains, a prolongation of the Oquirrhs. Most of the ores in this region come from a small mountain of limestone nearly surrounded by porphyry, into which porphyry dykes have been thrust and produced veins of ore. On the southwest side of this mountain at Silver City the pophyry itself has been cracked, and the fissures filled with other porphyry of later origin. This has produced mineral veins in the old porphyry. *Eureka* is a town of about 3000 people. It is situated on the north side of the mountain. There are two large mills here, two railroads, churches, and many business houses. The chief mines in this place lie on a

nearly vertical vein which is opened for about half a mile in length, and over 1500 feet in depth. The ores carry silver and copper chiefly, though there is some lead and gold. The principal mines are the Gemini, Bullion-Beck, Eureka-Hill, and Centennial-Eureka.

Knightsville is a little town about a mile east from Eureka, and lies at the foot of the mountain. The leading mines are the Godiva, May Day, Yankee Consolidated, and Uncle Sam. The ores occur in a flat vein, and are mostly silver-lead. Farther around the mountain, but in the same formation, are the Sioux, Utah, Carisa, etc.

Mammoth and *Robinson* are two towns lying in a little alcove on the western side of the mountain, adjoining the Mammoth vein. This is a broad vein in limestone carrying copper, silver, and gold, though there is some lead. The mines here are the Mammoth, Grand Central, Ajax, and Lower Mammoth. The vein is opened to the depth of 2000 feet, and has miles of underground workings. The population of the two towns is about 1500. There are two mills and three railroads in the camp.

Silver City, a town of about 1000 people, is situated about a mile south of Robinson in an open country. Its mines are all in porphyry. The two principal veins, the Swansea and Sunbeam, are about a mile apart, and run nearly north and south, but parallel. The Swansea carries silver-lead ore and the Sunbeam the same, but with considerable copper. South of the Sunbeam is Treasure Hill, a small mountain of porphyry, containing several good veins. On the contact between porphyry and lime, south of the Star mine, is the Dragon which has very great bodies of iron ore. This deposit has furnished many thousands of tons of iron. The Star mine lies between the Dragon and the Mammoth mines. It has produced much silver-lead ore, and also contains large bodies of low grade gold. The chief mines here are the Star and Swansea (Fig. 25).

Park City is located on the eastern side of the Wasatch, at an elevation of about 7000 feet. It contains about 4000 people, has several churches and mills, one sampler, and one zinc smelter. The principal vein in this camp is called the Ontario. It runs much in the same way as the Bingham series of veins, and is opened to a depth of 1700 feet. The ore is mostly silver-lead, and occurs in very large quantities. The vein seems to be a contact between lime or porphyry and quartzite, and has been opened up for a distance of nearly two miles.

The principal mines are the Ontario, Daly West, and Silver King. All the mines here are wet, and so have to be drained by pumping. There are several veins in the camp. Quite a number of other properties have produced considerable ore.

Alta is one of the first camps which were opened in the state. It is situated in the heart of the Wasatch, west of Park City, at an elevation of 8500 feet. At one time it was a large town, but has been wiped out several times by snowslides and fires. It lies in the midst of the grandest scenery in the Wasatch. A tramway runs down to the valley and connects with the railroads. The largest mines are the Vallejo, Flagstaff, and Emma. The Grizzly now produces the most ore. Millions of dollars worth of ore have been produced here, containing much silver and lead. The veins are in lime, and have been developed down to the underlying granite.

Frisco lies in the heart of the desert mountains of central Utah, nearly west of Beaver and Marysvale. The elevation is about 7000 feet. The O. S. L. R. R. reaches this camp. The veins run mostly northwest and southeast, and are in lime for the most part. In places they widen out into immense ore bodies. The Hornsilver is the leading mine. The ore is chiefly silver-lead. There are other veins in porphyry, quartzite, and lime which carry much copper. Among these are the Cactus, O.K., and Copper Ranch. The Atlas mine, located near Milford, has produced much silver, lead, and gold.

The *Star District* in the Mineral range, east of Milford, has produced very much silver-lead ore from the old Star mine. The mineral occurs in lime in very large chambers, and carries much iron. This camp is now being revived, and bids fair to become a great producer.

Indian Creek, near Beaver, has considerable gold ores.

Marysvale lies east of Mt. Belknap. The mines are in the midst of rugged mountains (Fig. 17). They have produced some gold, lead, silver, and mercury. Alum is found in the Sevier Canyon below Marysvale.

Gold Mountain, or *Kimberly*, which lies at 9000 feet elevation on the north side of Mt. Belknap, really belongs to the Marysvale region. Its principal veins lie around this peak, running northwest and southeast, and carry gold ores. There are two mills here. The Sevier, Annie Laurie, and Breckenridge are the chief mines.

Iron County. — This region, especially at Iron City, has great de-

posits of iron ore. The mineral is found on the surface in great blow-outs, or conical peaks and ridges. There are about 3,000,000 tons of ore in sight, which run from 45% to 60% iron. Without doubt, silver, lead, or copper will be found below. In early days, furnaces were erected at the mines, and a fine quality of iron was made, but lack of railroad facilities prevented further development.

Silver Reef. — This is a peculiar section because of its silver ores lying in flat veins in sandstone. The camp is located in the hot region near St. George, south of the Pine Valley Mountains, at an elevation of 3000 feet. The leading mines are the Barbee and Walker, Stormont, etc. The ores are easily treated in local mills by what is known as the free-milling process.

Dugway lies on the northern end of the Dugway Mountains. There are several veins running out from a porphyry core, and carrying much low-grade silver-lead ore. About ten miles north of Dugway is the Granite range, which has numerous veins of silver-lead ore. In the southern end of the Dugway range is Detroit district. This has many veins of iron ore. There are also a few veins of copper ore, some of which carry bismuth. Years ago a copper smelter was erected at the Warm Springs to work these ores.

Fish Springs. — This range lies east of the Deep Creek Mountains, in the desert. On the northern end there are two or more beautiful veins of high-grade silver-lead ore. The veins run about northwest and southeast and are rather small. The Utah and Galena are the chief mines.

Deep Creek Mountains. — On the western edge of Utah rises the highest peak (except in the Uintas) in Utah. Around it lie many mines and mineral deposits, particularly at Granite, Dry Canyon, Clifton, Gold Hill, and Dutch Mountain. The veins at Granite carry gold; those at Dry Canyon have some silver-lead ores. Clifton lies in the lower part of the range to the north. It has a series of veins in granite which go well in silver and lead; another series, also in granite, which go high in copper and gold; and still another series, which is in lime on or near the contact with granite, and carries much silver-lead ore. The Midas mine is near Clifton. The ore lies in lime and carries gold. A mill is located on this property. Gold Hill lies three miles north of Clifton. It has three sets of veins. The first consists chiefly of gold and copper in marble; the second has a series

of copper-gold ores on the contact of a porphyry mountain with lime; the third series is close to the contact of lime and quartzite, and centres in an isolated peak which is honeycombed with veins of gold, iron, lead, and arsenic. The Cane Spring is the leading mine in the first series. The Alverde is the main property in the second series, and is the richest mine in the camp. The Gold Hill is the chief mine in the third series. There is a gold mill in this camp. Dutch Mountain is located just north of Gold Hill. There are a number of veins here carrying silver, lead, and copper. The copper veins are on the south. The silver-lead veins run in an arc of a circle and are in lime. The Monster, Consolidated, and Uncle Sam are the chief prospects. On the western side of the Deep Creek range, nearly opposite Granite, are several veins of gold ore in quartzite.

Other Localities. — Sixteen miles west of St. George is an old copper mine located in the Beaver Dam range. It produces much copper, and has a smelter located at St. George for reducing its ores. State-line is a promising new gold camp. It lies on the edge of Nevada. The Wa Wa Mountains, west of Frisco, have large bodies of iron and some lead and silver ores. The West Tintic range, situated some twenty-five miles west of Silver City, has considerable silver-lead and gold ores. The leading mine is the Scotia. Still west of the West Tintic range is Desert Mountain, with its numerous copper veins. A few miles north of the Scotia, and in the West Tintic Mountains, is Death Canyon. There are some good copper and silver-lead ores here. West of Grantsville, in the Aqui range, is the old Jennings mine, which has marketed much silver-lead ore. Northwest of Grantsville, along the edge of the lake, are the Lakeside Mountains. Large quantities of lead ore occur here. North of Ogden, in the lofty cliffs, considerable silver-lead ore is found. The ores seem to lie mostly in rather flat veins in lime. Near Willard is a large deposit of iron ore. Other fine ores of iron are also found near Morgan, in the Norway iron mines. In the northwestern corner of the state lies Park Valley, with quite a deposit of gold ores.

Questions. — Name the chief minerals deposited in veins. Explain how they are deposited. What are base ores? Dry ores? How do ore bodies occur? What is their value? How do limestone deposits differ from other deposits? Are the metals found in the

pure state? How is mining done? What is a level, shaft, tunnel? What tools are used in mining? What is sorting? Assaying? Sampling? Smelting? Roasting? Concentrating? What are the leading smelters? What was the first mining camp opened in Utah? When was silver first found in Utah? Lead? Describe Bingham, its principal veins, mines, and products; also in the same way Stockton, Ophir, Mercur, Eureka, Knightsville, Mammoth, Silver City, Park City, Alta, American Fork, Frisco, Marysvale, Gold Mountain, Iron County, Silver Reef, Dugway, Fish Springs, Clifton, Gold Hill, Dutch Mountain, etc.

Search Questions. — Why are not veins of minerals found in lava in Utah? Why are not ore bodies continuous? Why are not the metals found in the pure state? What is a windlass? Whip? Whim? Hoisting plant? Describe a pick, shovel, and all other tools used in mining. What is an automatic sampler? Why is lead used in smelting gold and silver ores? Why is it not used in copper smelters? Why are silica, lime, and iron used in smelting? Describe the concentrating process. Describe the milling process? How do you suppose gold was deposited only on the outside of the rocks at Mercur? Are there any smelters, mills, or concentrating plants near you? If so, find out all about the way they treat the ores. What is slag? Bullion? Matte?

CHAPTER IV

GREAT SALT LAKE

Great Salt Lake. — In the first part of this book, under the head of Geological History, we found that the Great Basin, extending from the Wasatch to the Sierras, was occupied by an immense lake. Afterwards this was divided, forming a lake next to the Wasatch and another next to the Sierras. To that eastern lake in its later history the name Bonneville has been given, after an early explorer, Captain Bonneville. It appears that this basin, when first formed, had an outlet possibly to the south. At any rate the basin appears to have been dry, which may have been caused by an excessively dry or hot climate at that time. But as the Ice Age came on, either there was a great increase in the moisture, or the climate became cooler, or both, and so the basin slowly filled with water.

As the lake grew deeper the waves formed beaches one above the other on the shore. The size of these beaches was proportioned to the time the water remained at the same level. At last the lake rose so high that it became a body of water 1200 feet deep and covered 18,000 square miles. It spread over most of the present settled part of Utah west of the Wasatch. When the water reached this point it ran over the rim of the Great Basin at its lowest point which was Red Rock Gap (Fig. 27) at the northern end of Cache Valley. There the waters formed a stream

about a quarter of a mile wide which flowed out into the Portneuf River and thence into the Snake, Columbia, and the Pacific. The river cut its way down through the rocks and débris about 400 feet. As this was a slow process, the lake left beaches along the shore as it fell (Figs. 27, 28, 29, 32). These shore lines were laid over the old ones made when the lake was rising.

FIG. 27.

Old outlet of Great Salt Lake at Red Rock Gap. The level part in the middle is about a quarter of a mile wide, and was the bottom of the river. The hills in the foreground were cliffs on the edge of the river. The table-land in the background was the shore when the lake was the highest.

At all stages of the history of this body of water the waves and currents formed bars, beaches, and deltas of the most magnificent proportions. The greatest bars are those at the point of the mountain south of Draper, and at Stockton (Fig. 46). The largest beach was the delta formed at the mouth of the Provo River which is now called the Provo Bench. This was formed when the lake was at its lowest level while it still flowed through the outlet. Doubtless

the water was at this point a very long time till the close of the Ice Age. After that the evaporation from its surface took away more water than flowed into the lake and so there was no water to flow out. The surface of the water then grew lower year by year because of the evaporation.

As mineral matter which is dissolved does not evaporate as the water does, so the water that is left behind will contain more and more of it as the years go by. This is

FIG. 28.

The old shore line of Great Salt Lake, called the Provo Beach, about 500 feet above the present level of the lake, and about 200 feet wide here. Sagebrush in the foreground. Tips of the Wasatch in the background.

true of Great Salt Lake, for it has been a very long time since the lake had an outlet. Now the water contains 25% of solid matter dissolved in it, or $\frac{1}{4}$ of the whole is salt. Now the lake covers scarcely 1700 square miles, or less than a tenth of its former size. It is about 70 miles long by 30 wide. The average depth is about 12 feet. Since the Ice Age the bed has been filled with about 200 feet of sand and mud.

When the lake was fresh, its shores were frequented by musk oxen and other animals like the moose and cari-

bou, and its surface by ducks, geese, and swans. The water was full of salmon, white fish, trout, graylings, chubs, and suckers. After the lake ceased to flow through its outlet the salmon could not get back into the lake (they go to the ocean every year), and so came no more. It is probable that the graylings and white fish perished as the water became briny for the streams were too small for them. But the other fish ascended the streams which flowed into the lake, and have remained there ever since.

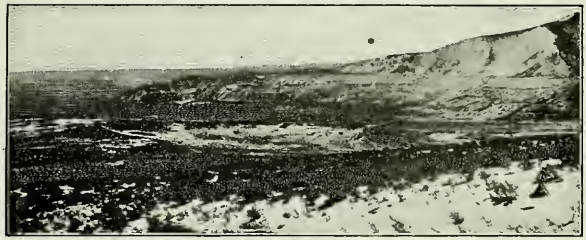

FIG. 29.

Old beaches of the lake near Chamber's station. The uppermost beach was the highest point ever reached by the lake.

It would be impossible to explain the presence of these fish in the streams of Utah, unless we knew that the streams were all once connected with the same fresh-water lake.

At present, contrary to all expectation, Great Salt Lake contains more life than any other body of water of its size in the world, but there are no fish or large animals in it. The animal life consists of beautiful little shrimps about a quarter of an inch long, of which there are hundreds in every bucket of water in June. Upon these shrimps there preys a little worm, the larva of a small fly. These worms also live in the water. When the larvæ go through the

transformation stage they attach themselves to the little, globular, yellowish-green seaweeds which are about a quarter to half an inch long, and are present in the water by millions. At last the larvæ hatch out into little greasy flies which sit upon the water in black masses in places. Upon these the seagulls feed, though they are not their main food. The shrimps feed on the seaweeds.

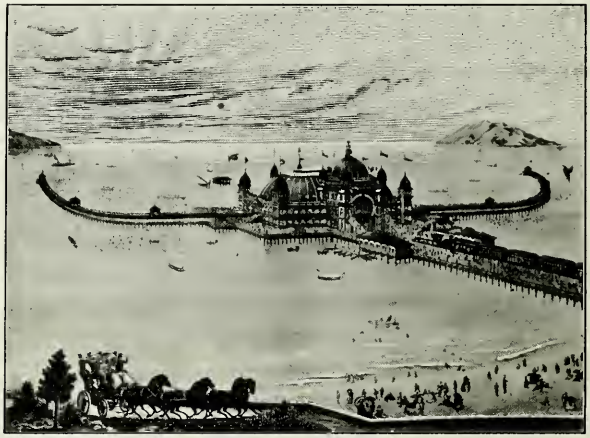

FIG. 30.
Saltair, the greatest bathing resort on the lake.

Since Great Salt Lake has no outlet, its surface varies from year to year, according to the amount of rainfall and evaporation. The annual variation is about sixteen inches. Under ordinary conditions the lake will rise a foot for every increase of an inch in rainfall above the normal, and will fall in like proportion for every decrease. It is, therefore, twelve times as sensitive to climatic changes as the rainfall. From this it was demonstrated years ago that

climatic changes go in cycles or periods. The shortest cycle is about three years long. These cycles are also parts of still greater ones, and include about three of the shorter periods. The larger periods are parts of still greater ones. Since historic times began Great Salt Lake has varied sixteen feet in its surface. In the winter of 1901 it was at least two feet lower than the lowest point ever known.

Within the last ten years the increased saving in the use of water for irrigation has greatly lessened the amount

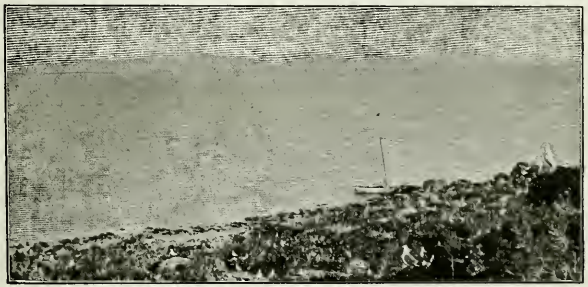

FIG. 31.

Hat Island on the desert side of the lake. Desert mountains barely visible in the distance. This is the nesting-place of myriads of seagulls, pelicans, and cranes.

flowing into the lake, so that the surface no longer follows the variation in the rainfall, but has steadily decreased in size. This will continue until such time as the reduced inflow into the lake caused by irrigation equals the amount of evaporation from the lessened area of the lake. Then the surface will remain stationary or follow the climatic variation. Should there be still further increase in the saving of water for irrigation, the lake will continue to fall under ordinary climatic conditions. The waters of the

lake are so dense that they kill all vegetation within their reach on the shore, and all fresh-water life in the streams that flow into the lake as far as the salt water can go. There is nothing but flies and seaweeds in the water to eat, and therefore birds do not frequent the region except to nest on the islands. There are several islands such as Hat, Carrington, Strong's Knob, Gunnison, etc., which are the nesting-places of myriads of gulls, pelicans, and cranes. Valuable guano has accumulated in some of these places.

FIG. 32.

Great Salt Lake from the Provo Beach back of Black Rock. Stansbury Island in the distance. The old Black Rock bathing resort below.

Though the air is very invigorating and healthful on account of the salt spray, there is very little sailing upon the lake because of the unpleasant effect of the salt which crystallizes upon the body and clothes in thick scales from every drop of water which strikes them. Salt water soon destroys leather and rubber and causes disagreeable cracks in the skin, when it is not washed off by fresh water. The waves are very heavy and roll lazily even in severe storms.

The shores of the lake are in many places very beauti-

ful, and the islands are remarkable for their silence and solitude.

One of the greatest pastimes of the people of Utah, from the earliest period, has been bathing in the lake. Very expensive resorts have been built upon its shores, the most magnificent being Saltair (Fig. 30). The water is so dense that a person floats in it with ease, having nearly one-third of his body above the surface. It is, however, very easy to drown because the greater density of the head tends to tip the body over, and consequently some effort is required to keep erect. The water is very irritating when drawn into the lungs. The pleasure of swimming in this peculiar water is very great, not only on account of the unusual sensation of floating so easily, but also because of the stimulating effect of bathing in so salty water. There are about 200,000 people who go out to the lake annually. The present elevation of the surface is about 4205 feet (Fig. 30).

Great Salt Lake was preceded by a still larger lake which extended to the Sierras. This lake dried up, at least partially, and its bed was divided by an elevation of the land in central Nevada. Afterward both parts filled with water. The eastern lake was called Bonneville. This overflowed in the Ice Age, and after that partly dried up again. It is valuable for the moisture it furnishes for bathing, and for the amount of salt produced along its shores.

QUESTIONS. — From what did Great Salt Lake come and how was it formed? What preceded it? Did it ever have an outlet and where? Why did it rise? Why did it fall? What evidence have we of its former level? What was its greatest size, what is it now? Where are the greatest bars, beaches, and deltas? Why did it become salty? What was its greatest depth and what is the average now? What kind of life existed on and in its waters, and why do we know it? Is there any life in its waters and what? Does the surface of the lake

remain stationary? If not, why not? What do you know of cycles? What effect, if any, does irrigation have on the lake? How much solid matter is in the water in percentage and total quantity? What kind of life exists on its waters and islands? How much sailing is there on the lake and why? How does the water act toward bathers in comparison with fresh water? What attractions have its shores? What is the chief pastime of those who frequent its shores? What is the elevation above the sea? Can a person drown easily in its waters?

SEARCH QUESTIONS.— Would artesian wells be possible under the old lake beds and why? How do we know that the bed of the lake was dry at first? How do we trace its history since? Of what value has the old lake been to the people of Utah? Will the lake dry up entirely. If not, why not? What would cause it to overflow again? Can you explain why so salty water supports so much life? What three elements are there in the life which balance each other and are essential to this balance? When will the water of the lake begin to deposit salt on its bed?

CHAPTER V

CLIMATE AND LIFE

Climate. — The climate of a region is governed by the elevation above the sea, the latitude, the rainfall, and the prevailing winds. Since Utah has all elevations from 2700 feet above the sea to a region of almost perpetual snow, her climate varies from that of the Tropics to the Arctic. Our winters vary from almost nothing to eight months long. So a person living in Utah can have almost any temperature he wants at any time of the year. When the heat becomes too intense in the lower valleys in the summer-time, he needs only to take a few hours' ride into the mountains to get where it freezes every night of the year. One peculiarity of Utah weather is that the rainfall is everywhere comparatively slight, most of it falling in the winter-time and piling up in the mountains as snow. The air is therefore bracing and dry, and is very invigorating and stimulating to the system. Because of its clearness the air makes all things seem near and sharply defined (Figs. 9, 11, 15, 28, 32).

In the *St. George* region the annual temperature is about 60° Fah., and the rainfall seven inches. There is an occasional fall of snow, and severe frosts occur so that oranges and lemons will not grow and even figs are often killed (Fig. 48).

In the *Green River* region the rainfall is only about

four inches per annum and the temperature nearly that of Salt Lake City.

In *Central Utah*, outside of the mountains, the average rainfall is less than eight inches per annum and the annual temperature about 52°. Here the peach and the common fruits including the English walnut and almond thrive, but the fig, orange, and lemon will not grow. The winters are about six weeks long, and begin about the first of January. The falls continue to the close of the year, with clear skies, cold and bracing air and little wind. The coldest night in the winter seldom reaches zero. The summers are generally tempered by occasional showers. Since there is little wind, there is less dust than would be ordinarily expected during the summer-time. There is a brief period in February and March when the roads are muddy from the melting snows and occasional rains. There is almost no sleighing because the snow seldom lies long on the ground. During the rest of the year the roads are generally fine.

In the *higher valleys* of the mountains, such as Parley's Park, Weber, Cache, and the Upper Bear River, there is sleighing several months in the year. The temperature sometimes goes down to 20° below zero. The summer climate is cool and delightful.

There are few places even in the higher mountains where the rainfall exceeds twenty inches per annum. Salt Lake City has the most humid climate of any town in the valleys, because it is situated on the southeastern corner of Great Salt Lake and with high mountains on the east. The prevailing winds bring moisture in from the lake because they are from the northwest. The rainfall is about 17 inches per annum.

The valleys are generally warm and free from high winds, because of the lofty mountains bordering them, and because of their direction. Cyclones are almost unknown in Utah, though occasional gusts of wind having a velocity of fifty miles an hour come down from the canyons or cross the valleys.

The climate of Utah varies in temperature from that of the Tropics to that of the Frigid Zone, according to the elevation. The rainfall is very small, and the air is dry. The region is quite free from storms because the Great Basin is really an isolated plateau around whose base the storms pass, mostly to the north, seldom rising over its crest.

QUESTIONS. — What governs the climate of a region? Why has Utah such a varied climate? What is peculiar in our climate? Describe the climate of the St. George region, Green River region, central Utah, higher valleys, Salt Lake City. Why is Utah free from cyclones?

SEARCH QUESTIONS. — Why is it always cool in the shade in Utah? From what direction does the moisture come which is found in Utah? How does the Weather Bureau predict the coming of storms? Is there anything in the situation of Utah that makes it specially hard to predict with certainty? How is the annual temperature found? Rainfall? Relative humidity? Wind movement? What is the rainfall of your region? Describe the climate where you live.

Soil. — There is no part of Utah which has a black, loamy soil, except the borders of marshes and some of the high mountain meadows. This is due to the fact that for thousand of years the climate has been much the same as now, and the vegetation has been too scanty so that there has been no accumulation of decayed plants to form loam. The winds also blow the dead herbage away every season. Outside of these limited areas of loam the soil

of Utah throughout the Great Basin region is gravelly, except the centres of all the valleys where there are large bodies of alkaline clay soil. This gravel is very porous, and is admirably adapted to crops. The clay soil is just the reverse. In southern Utah in the St. George region red sand prevails. The rivers here are roily and the irrigating water carries mud over the sand so that the soil becomes well adapted to crops. In eastern Utah there is a soft clay, which supports fair crops, but easily washes away.

QUESTIONS. — What part of Utah has a loamy soil? Why does not all of Utah have such a soil? What is the general character of the soil? What part of Utah has a clay soil? What is the soil of your region?

Life Zones. — The accompanying map (Fig. 33) shows the distribution of animals and plants in Utah. There are but two life zones, the Tropical and Temperate. What has been called the third, the Frigid, is really but a modification of the Temperate. The *Tropical Zone* is limited to not less than 60° to 56° annual temperature, and includes the so-called Subtropical. Its characteristic plant in Utah is the creosote bush. Other plants which also grow in this region are the Joshua (Fig. 38) and the bush cactus (Fig. 37). This zone is found only in the St. George region (Fig. 48).

The *Temperate Zone* is divided into the Lower, Middle, Upper, and Frigid (called alpine in our region).

The *Lower Temperate* is limited by an annual temperature of not less than 50°. Its characteristic plant is the juniper or white cedar, as it is called in Utah (Figs. 15, 16, 35). It is also represented by the sagebrush (Figs.

1, 46) up to where the Middle Temperate begins, but the sagebrush goes to the upper limit of the Middle Temperate also.

The characteristic plant of the *Middle Temperate* is the scrub oak (Fig. 34), and is found only in the mountains except in the upper end of Cache Valley.

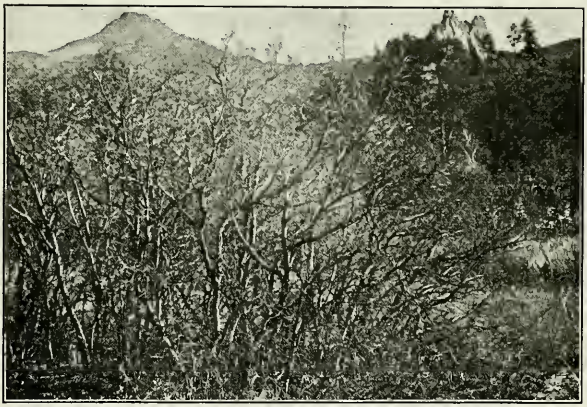

FIG. 34.

Scrub oak brush, characteristic of the Middle Temperate, growing on the mountains of northern Utah.

The *Upper Temperate* is represented by the spruces and firs of the high mountains up to the timber line, and includes all our great summer resorts (Figs. 7, 9).

The *Frigid* includes the treeless mountain peaks and the meadows near timber line.

QUESTIONS. — Trace the life zones on the map and their relation to the mountain ranges and valleys. What are the life zones and their limits in temperature as far as given? What are their characteristic plants? In what zone do you live? How do you know it? Do you know the oak brush (Fig. 34)? Sagebrush (Figs. 1, 36)?

Cedar or juniper (Fig. 35)? Spruce (Fig. 9)? Fir (Fig. 7)? Yellow pine (Fig. 42)? Joshua (Fig. 38)? Creosote bush?

Flora. — It is a well-established fact that plants originated in the Tropical Zone and scattered thence throughout the world. As they spread they were adapted to the various soils and climates where they were. During the Utah Coal Age the flora of Utah was tropical. During

FIG. 35.

The Utah juniper, the characteristic bush of the Lower Temperate, common in central and southern Utah.

the following or the Age of Mammals the flora gradually changed to that of the warm Temperate Zone, and the vegetation was much like that of the Eastern states as it is now. When the Ice Age or Glacial Period came on, the cold became such that all the plants of the Temperate Zone were killed and only such as could exist in the Arctic regions (or high mountain tops) grew in the very cold valleys, as all the lower valleys were then. The flora of the Temperate Zone was then driven out of the Great Basin and existed only in the warmer regions of southern

Arizona and northern Mexico. The mountains were covered with perpetual snow. As the Ice Age came to a close, giving way to a warmer climate, it left the valleys and mountains bare during the summer, and the former became so hot that the alpine plants could not exist in them, and thus they had to climb the mountain slopes, following up the retreating snow year by year, or perish.

FIG. 36.
Rabbit brush, common everywhere in the valleys of Utah.

As the climate in the valleys grew hotter it became adapted to the plants of the Temperate Zone then growing in Arizona, and these gradually crept back over the rim of the Basin on the south and occupied the valleys. The great Wasatch Mountains formed a barrier to their coming in from the east, and the cold climate of the north was also a barrier. The Sierras formed another barrier on the west. Thus the south was the only region from which vegetation could come. The climate of the Great Basin continued to get hotter, and the plants of the Temperate Zone crept up the mountain sides following close

behind the alpine plants, until at last the latter were crowded on the tops of the highest peaks. Thus we find every very high mountain possesses the same alpine flora, though the peaks are separated hundreds of miles.

We find that Utah's climate changed from tropical to temperate and then to arctic in the Ice Age. Since then it has swung back till the St. George region has become tropical again. This has resulted in migrations of the floras and in a great change in the plants to suit the climate and soil in which they grow. We find the same alpine flora on all the high mountain tops regardless of their separation from one another.

As the plants of the cooler Temperate Zone left the valleys, those peculiar to the lower Temperate followed over the Great Basin and possessed the land. They in turn have been crowded out from the St. George region by the hot climate and the tropical vegetation, till the latter has crept up the Virgin River past Silver Reef as far as Springdale.

In this struggle for existence, which has continued since the Ice Age, we find many devices of nature which have been used for the purpose of enabling the plants to better resist the climate, soil, and animal enemies to which they have been exposed. In southern Utah are very many plants which have developed spines to protect them from being eaten by the larger animals (Figs. 37, 38). We find many plants without leaves, the bark or skin of the stems having been changed so as to perform the office of leaves. This is found among the *Cacti* particularly. Other plants have developed thick leaves covered with resin to protect them from the sun. We find the leaves of all, except some annuals, have been reduced in size, as well as the plants

themselves. We find that nearly all other herbs which live longer than one season have been reduced to fleshy underground roots buried deeply beneath the surface of the ground so that at the first moisture and warmth in the spring they may rapidly send up stems which in a few weeks blossom, fruit, die, and leave no trace behind them, while the roots have stored up enough nourishment to keep them alive until warm rains come again either in the fall

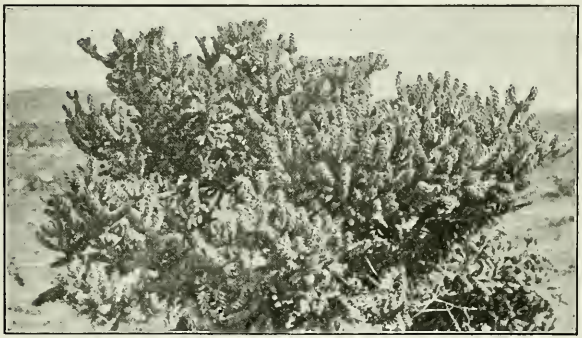

FIG. 37.

Bush cactus, common in the St. George region.

or spring, and are so far below the surface that they do not dry out in the hot summers.

Nature's most favorite device in hot and dry regions is to make a multitude of plants which start from the seed in the spring. These go through the entire round of life and produce seeds again. The latter mature, and on the approach of the dry season fall upon the soil, where they are covered up or blown into cracks, and because of their smallness and denseness are able to resist the summer's heat. They are ready at the first warm rain of fall or spring to start the round of life anew. We find this state of things

also wherever the juniper grows, in as well as out of the Great Basin.

In the oak zone, or Middle Temperate, and all the climatic zones above it to the alpine, we find a different state of affairs. Here the summer moisture is such that the seeds of annuals are not secured against rotting in the moist ground, and so nearly all the plants live for more than a year, and therefore have developed many devices for protecting their roots against the rigors of winter and spring. For, in this region, either the snows are deep or the winter frosts severe. In the lower region, where the ground is only partially covered with snow in the winter and there is much freezing and thawing, the roots are generally protected by dense clusters of dead leaves or by masses of hair or wool, which act as refrigerators to prevent them from starting before their time. This is particularly true of plants growing in the oak zone. In the higher regions, where snow lies deeply on the ground through the winter, plants do not require this protection for their roots, because the snow acts the part of a warm mantle. Here the roots are protected only against the cold and changes of spring.

The study of the way plants are fitted to the climates in which they grow is most interesting. There is a remarkable similarity between the plant devices and those of animals that hibernate or hole up in the winter in the same region.

Because of the dry air the moulds, rusts, and other fungi are few. In fact, this is also true of the entire vegetation. The climate is so varied in different parts of Utah that there is a great number of different kinds of plants (there being about 3000 species) though the quantity of indi-

viduals is small. The hot region of St. George has a flora peculiarly its own. The plants of this region which are most abundant are the *Cacti*, which are found in the most fantastic shapes and have the most beautiful flowers. Other queer plants in this region are the Joshuas (Fig. 38) and other yuccas. These are large plants with sword-shaped leaves arranged in swabs at the end of the stems. The mesquit, creosote bush, and desert willow are also

FIG. 38.
The Joshua, the most peculiar shrub in Utah.

peculiar. Since the summer is so dry and hot, the ground in spring only is often covered with a carpet of the most brilliant flowers, but in a month they are dried up and gone. Nothing but the seed is left to live through the hot summer and start life anew in the coming spring. It sometimes happens here that in the fall there are unusual rains; then the flowers start up and bloom, mature, and blow away, just as though it were spring.

All that part of Utah south of Ogden, including all the

valleys and all the slopes, which are covered with the juniper (see Fig. 35) and piñon, have the same peculiarity as the St. George flora; namely, the ground is covered with beautiful flowers in the spring, which soon dry up and blow away. But the kinds of flowers are quite different. This whole region is covered with sagebrush (Fig. 36), shadscale, and rabbit-bushes. The most beautiful flower is the sego lily. It is the state flower. Another lovely plant is the evening primrose, which blossoms only at night. There are many beautiful cactus flowers. The Mexican poppy abounds.

In the regions covered more or less with alkali there are peculiar plants with fleshy leaves and inconspicuous flowers which belong to the beet family (Fig. 31). These ungainly plants, which seem to have no value, are really the only ones which nature uses to make the deserts suitable to support life, and eventually redeem them. This is due to the fact that these plants cannot thrive without much alkali, and therefore their stems and leaves take it up from the ground. When they mature and die, the winds dry them up and carry the alkali with the leaves far away. Another peculiarity is that some of these plants have very large roots and live on the edge of the deserts where no other plants will thrive. As they grow from year to year the roots increase and finally raise mounds of earth, sometimes five or six feet high, above the ground. The snows of winter and the summer rains falling on these mounds wash out the alkali from them and sweeten the soil so that other plants may live upon them. In addition these mounds are scattered so thickly over the ground that the winds blowing over them rapidly drift the spaces full of sand and dirt. This covers the alkali below

and raises the ground so that whatever salty matter there is mixed with the new soil will also drain off when wet by the melting snows and rains. Thus year by year the deserts grow narrower and smaller, and will in the end entirely disappear, or be confined to very small alkaline lakes and flats.

The vegetation of Utah differs from that of the East not only in the small quantity of plants of all kinds, but in the great number of kinds. This is due to the different climates caused by the varying elevations, and not by latitude. Utah has an unusually large number of brilliant flowers. The deserts of Utah have developed a very peculiar flora adapted to living in a highly alkaline soil, and these plants are waging so successful a warfare against the deserts that they will ultimately redeem them.

Timber. — The timber of Utah which is useful for lumber is confined almost entirely to the region in and above the oak zone. The only exception to this rule is in the cottonwoods, which are found along the principal streams. The trees of the higher mountains are the white fir (Fig. 17), spruce (Fig. 9), red pine or Douglas fir, yellow pine (Fig. 43), bastard pine, aspen, mountain mahogany, hard maple, and narrow-leaved cottonwood. The white fir, spruce, and red pine are beautiful pyramidal trees, and abound at high elevations. The last two are very valuable for lumber. The firs produce a fine balsam and the roots of the spruce are used for baskets by the Indians. The yellow pine produces the finest lumber, and is a stately tree. It is found only sparingly from Parley's Park to Fish Lake, but beyond that forms very large forests. It grows in the oak zone only. The bastard pine is valuable only for its resin and grows at

high elevations. The aspen is everywhere in middle elevations in the mountains. It is seldom large enough for lumber, but makes fine kindling wood and lagging. The bark is a valuable medicine. The mountain mahogany is scarcely more than a shrub growing in the oak zone. The wood is as hard and compact as boxwood. The hard maple seldom reaches the proportions of a tree in the wild state. It grows along the streams and makes a fine shade tree when cultivated. The narrow-leaved cottonwood grows along the mountains streams, is sometimes planted, and used for lumber.

Throughout the lower slopes, low hills and tablelands and below the oak zone, but not in the valleys, Utah is everywhere covered by large areas of juniper, called cedar (Fig. 35), and also by piñon. The piñon is a small pine tree, seldom reaching thirty feet in height, which bears a large seed that has been the main support of the Indians for ages. The juniper is also a scraggly bush or small tree of about the same size. Both of these are evergreens, and produce large quantities of resin and are everywhere used for posts and fuel.

Among the bushes prevalent in Utah the most common is the scrub oak (Fig. 34), which covers the Wasatch, Oquirrh, Aqui, Uinta, and Coal Ranges south to the rim of the Great Basin. The other common shrubs are the birch, willow, choke-cherry and service-berry.

The valuable timber of Utah all belongs to the evergreen class and is confined almost wholly to the high mountains. The valleys are destitute of timber. The hills are covered with low trees or large bushes of juniper and piñon in the warmer parts of the Great Basin. In the eastern part, where it is more moist and colder, they are covered with scrub oak.

QUESTIONS. — Where did plants originate? What was the flora of Utah at first? To what did it change? Where did the temperate flora go? What was on the mountains? How did the flora change as the climate grew warmer? Why are the flowers on the different mountain peaks the same? From what region did the temperate flora come? Why did it not come in from the east and the west? Why not from the north? Where is a tropical flora found now? What devices have plants used in the St. George region to protect themselves against the climate and animal enemies? What is peculiar to the spring flora there? Do plants ever bloom twice in a season there, and why? What is true of the juniper region? Does the oak zone differ from the juniper zone, and how? What protection do plants use against the climate in this zone? Of what value is snow to plants? What is the chief peculiarity of the Utah flora? What are the peculiar plants of the St. George region? Why are there so many annuals? What is the peculiar vegetation of the Great Basin? What is the most beautiful flower? Describe the plants that grow in highly alkaline soil. For what are they useful? How are the deserts being redeemed? To what regions is the timber confined? What are the trees of this region, and for what are they used? Which makes the finest lumber? Where are the largest forests? What have medical value? What are the best trees for planting for shade? What trees are most used for posts and fuel? What are the most common bushes in your region? Mention the common ones in Utah.

SEARCH QUESTIONS. — Do any plants hibernate or hole up as do the animals? What provisions do they make for winter? What makes them start in the spring? Are there plants which live on one another, and what do you call them? How do plants protect themselves against enemies? How against climate? What devices are used to protect against cold, heat, and wind? Classify your most common plants in regard to life zones. Explain what is meant by the different floras climbing the mountains and coming in over the rim of the Great Basin. Do plants walk? How do plants spread from one place to another? Mention every means that is used and the organs which the plants develop to bring this about. Has the struggle for existence been one against other plants or against climate? Why? What plants in your region are valuable to men for fuel, medicine, or any other use? How can you tell by the plants in your region what kind of crops the soil will produce best?

Animal Life. — Because of the scanty rainfall and sparse vegetation of the valleys of Utah animal life is not abundant. In southern Utah this life consists chiefly of lizards, which are both harmless and very abundant; of a few snakes, among them two or three kinds of rattlesnakes; and of insects, especially beetles. The birds are represented by the California quail, which is very abundant, the shore lark or desert sparrow, and an occasional vulture and hawk. The road runner and the mocking birds also occur, but are very scarce. The most peculiar animal of this region is the kangaroo mouse.

The animals of central Utah valleys are chiefly the squirrel, prairie dog, and the spermophile or ground squirrel, which, along with the lizards, are very common. The larger animals are the coyote, antelope, badger, and jack rabbit, the latter being very common. The birds consist chiefly of desert sparrows of various kinds, the English sparrow, meadow lark, turtle dove, hawks, pelicans, seagulls (Fig. 31), and ducks, which are very common around the lakes. Blackbirds, tule wrens, and the like are common on the marshes. Chubs, suckers, and trout are the prevailing fish. Introduced fish are the detestable carp, the black bass, etc. Insects are very common, especially beetles and butterflies.

One peculiarity of the desert regions is the absence of water. This causes the springs, which are scattered far apart, to be frequented by what seems like great numbers of birds, insects, and other animals. If there are trees around these springs they are filled with birds all day long which come here for water and make the air musical with their songs while they rest.

The mountains of Utah, which are well watered and

high, support the greatest number of animals. Insects of all kinds are very abundant, and though there are not as many birds by far as are found in the East, yet they are always to be found. Few of them are musical. One great peculiarity of the western mountains is their perpetual silence. This is partly due to the scarcity of song birds and partly to the thin air, which carries sound such a short distance. The principal birds are sparrows, the water ousel, woodpeckers, flickers, blue jays, magpies, king birds, quails, grouse, hawks, eagles, and ducks, the latter frequenting the alpine lakes. The fish are mostly trout. Insects are common, especially beetles. The more common of the other animals are ground-squirrels, chipmunks, tree-squirrels, hedgehogs, cottontails, woodchucks, mountain rats, conies, or pikas as they are properly called. The larger animals are the lynx, wild cat, mountain lion, bear, deer, elk, and mountain sheep. Formerly mountain goats and buffalo existed in Utah, but they are now extinct.

Utah people have raised silk for a long time. The annual product is about 3000 pounds. Most of the silk is raised at Kanarra and southward.

The animal life of Utah is represented by thousands of species of insects, 78 species and varieties of reptiles, 327 species of birds, and 80 species of mammals. The reptiles are represented in species by 6 frogs, 3 toads, 24 lizards, and 19 snakes. The species of mammals embrace 8 bats, 4 rats, 13 mice, 5 hares, 2 skunks, 4 gophers, 10 squirrels and chipmunks, 5 ground squirrels, one each of muskrat, porcupine, pika, beaver, prairie dog, marmot, otter, badger, wolverine, weasel, mink, wild cat, lynx, mountain lion, antelope, elk, etc. There are 2 species of foxes, wolves, and deer, and 3 species of bear.

The animals of the deserts are scanty and small, and belong mostly to the reptiles and insects. Those of the valleys around the Wasatch are more abundant. Those of the mountains are hardly more than the animals in the valleys, but are somewhat more varied in kinds. The animal life of Utah is far less abundant than that of the East.

Questions. — Why is not the animal life of Utah abundant? Describe that of southern Utah, central Utah, the mountains. What peculiarity has the desert? Why do our mountains seem so silent? What are the common animals in your region? On what do they feed? Are any beneficial or injurious to the people? If so, how?

Search Questions. — What birds and mammals migrate? When? Why? What animals hibernate, and why? What animals hole up in winter, and how do they live? How do animals know when to come out in the spring? At what times do they begin to hibernate in the fall, and what provision do they make to live over winter? When do they come ont in the spring? Why do we have flesh- and herb-eating animals? What happens when they are not properly balanced, and how is the balance restored? How are the various animals protected against climate and enemies, and how provided with suitable organ? to enable them to thrive under the conditions in which they exisst Classify the animals according to the life zones in which they live; and mention the leading ones in each zone. What are the animals of your region? Classify them by life zones.

CHAPTER VI

AGRICULTURE

Irrigation. — Utah differs from Colorado and the East in having very few rains in the growing season, therefore a larger amount of water is required for irrigation than would be necessary even in Colorado. This amounts on an average to from two to four feet per square foot irrigated. To get this water on the land at the least expense the people selected their farms close under the mountains at the mouths of the canyons, where the streams entered the valleys, and, at first, made little ditches with a plough and scraper to carry the water out upon their lands. These ditches were divided according to the number of people who used the water. Thus settlements clustered around the mouths of canyons, and as they grew, the canals had to be widened and extended and made more uniform to supply the outer ranches. As the years went by, these canals became more expensive and were built by large corporations (Fig. 47). The most important canal is that of the Bear River, which cost over a million dollars and waters many thousands of acres. The farms are selected and laid out according to the slope of the country, so as to get a proper but not too great a fall for the water. The feed ditch runs upon the upper side of the farm, and from this laterals run to the various fields. The fields have little furrows every foot or so away run-

ning parallel to one another so that every part will receive the proper moisture as the streams flow down the furrows (Fig. 48). The ground is irrigated once a week, or less often, according to the crop and soil and the water available. Small grain requires but few waterings, while lucern and root crops require many. One advantage which irrigation has is that crops, within certain limits, can be ripened to suit the convenience of the farmer by withholding the water, or can be kept growing longer by continuing to irrigate them. On clay land the method of

FIG. 39.
Fruit scene at Junction, above the Henry Mountains.

flooding is often used because the soil is too compact to absorb enough while the water is flowing over it. The ground is therefore banked up in little squares which are filled with water and then allowed to absorb it. Reservoirs are much used in Utah (Fig. 45). Water-wheels are also employed on the Green River to raise water to the ditches (Fig. 46). The method of dividing the water generally in use in Utah is by weirs or flumes, in which partitions are placed according to the proportion of water owned by the parties using the ditch. It is very seldom

that water is measured by miner's inches, a method very common in California. Subsoil irrigation is not yet employed in Utah. It consists in carrying the water from the canyons to the farms and thence to the fields through pipes. From here the water also flows underground and rises through the soil from holes made in the pipes. If this method were employed the amount of irrigated land could be nearly doubled, because it would save the great loss by evaporation and seepage which occurs in the present canals and ditches.

Practically all of Utah has to be irrigated. Irrigation consists in carrying water by ditches upon the land to supply the place of rain.

QUESTIONS. — How does Utah differ from Colorado and the East? How much water is required to irrigate a square foot of ground? Why are the towns located at the mouths of the canyons? How are the ditches taken out from the streams, and how divided? Why have the people begun to build large canals? What are the three methods of irrigation? What advantage has irrigation over raising crops without irrigation?

SEARCH QUESTIONS. — What is the method of irrigation in your region? How many times in the season do you irrigate wheat, lucern, potatoes, and orchards? How is your water divided? What method of irrigation do you use? How can it be improved? Are there any reservoir sites in your region that could be made useful? Where would it be best to place them, and why? Are you sure you could fill them with water if you had them? Why cannot all of Utah be irrigated? Would the difference in the amount of ground covered by Great Salt Lake make any difference in the rainfall of adjoining regions? If so, why?

Agriculture. — This is one of the chief occupations of the people of Utah. The centres of most of the valleys have clay soil highly impregnated with alkali and are poorly drained. Therefore, they are not suitable for crops. The

slopes of the valleys are well drained, have a gravelly soil and a grade nicely fitted for irrigation. The most important valleys have large benches or tablelands (Fig. 29) which are nearly level, and were once the shore of Great Salt Lake. These make admirable farms. The quantity

FIG. 41.
Group of Shoshone Indians.

of water for irrigation in Utah is so small in proportion to the irrigable land that the cultivated area amounts to but a small part of the state. This land is valuable only if there is water to go with it. There are occasional years when small grain can be raised without irrigation: this is called dry farming, but the crops are uncertain. The chief products of Utah are hay, grain, root crops, and fruit. There is little native hay grown because the soil is

too alkaline. The people have had to resort to a plant belonging to the pea family called lucern or alfalfa, which produces from two to five crops each year. The colder valleys like Cache (Fig. 51) and Sanpete raise large amounts of small grain. Root crops are grown in great abundance throughout Utah. Sugar beets and potatoes are the chief ones. In fruit Utah occupies a leading position and is rapidly improving. All kinds of temper-

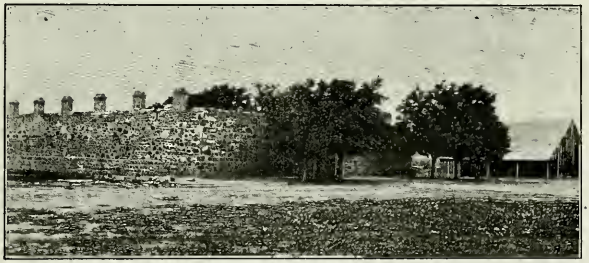

FIG. 42.

Old Fort Cove, built in early times as a refuge from the Indians. Notice the loop-holes for rifles between the chimneys.

ate fruits are raised. In southern Utah in the hot region figs, almonds, raisins, grapes, and cotton are raised in abundance.

QUESTIONS. — What is the character of the centres of the valleys? What parts are best adapted to crops? What make admirable farms? Is the cultivated area in Utah large in proportion to the total? Is the land in Utah all valuable? What is dry farming, and is it always successful? What plant is most used for hay, and why? What are the chief products in Utah? Name the localities in which each is produced to the best advantage?

SEARCH QUESTIONS. — What crops are raised in your regions? Can any increase be made in the quality or quantity, and how?

Grazing and Stock Raising. — Since but little of Utah is capable of irrigation because of the lack of water, the land is uncultivated by farmers, and would be useless were it not for the scanty vegetation which grows on the deserts and the abundant grass which once covered the mountains. The people early began raising cattle, horses (Fig. 44), mules, and sheep, till now the animals are

FIG. 43.

Typical grazing scene at the head of the Sevier. The country is covered with yellow pines. The low mountain mahogany appears in the right-hand corner. Mail wagon in foreground.

counted by the millions. The grass growing on the deserts has the peculiarity of drying up and still retaining its nourishment, so that in the winter, when snow covers the mountains, the stock spread out over the deserts and live upon this grass. In addition there are certain shrubs which furnish the greater part of the sustenance for stock. The chief of these is the winter fat (Fig. 11), a low shrub which is eaten close to the ground,

and is very nourishing because of the abundant seed which it produces, and which remains on the stems during the winter. There are two other shrubs upon which the sheep depend beside the winter fat. One of them is the shadscale, a thorny shrub belonging to the beet family, and the other the gray, but evergreen, sagebrush (Fig. 1). When the snows begin to melt off the deserts, so that the stock can no longer secure water to drink, the animals drift back to the mountains (Fig. 43) and follow the retreating snow, till in the height of summer most of the animals are found grazing on the highest mountains. The number of cattle raised is 400,000; sheep, 3,300,000; total sheep owned in Utah, 6,000,000; wool clip, 17,000,000 lbs.; horses, 71,000; mules, 16,000; hogs, 53,000.

QUESTIONS. — Why is Utah adapted to grazing? What is the peculiarity of Utah grasses? What shrubs do Utah animals browse upon? And why are shrubs better for winter food than grass when snow is deep? Why are animals driven from one part of the state to another at different seasons?

SEARCH QUESTIONS. — What is meant by overstocking a region? What harm comes of it? How can it be remedied? What part of your region is adapted to grazing, and what kinds of stock are raised upon it? Explain the methods of raising sheep, cattle, horses, and pigs in your region.

CHAPTER VII

SETTLEMENT

Settlement. — Utah was inhabited by wandering and uncivilized tribes of Indians until the sixteenth century, when Mexicans discovered it, and later made settlements at Monroe, Fillmore, near Oasis, and at Tooele. During the latter part of the eighteenth and the early part of the nineteenth century, northern Utah was much frequented by trappers and traders because of the abundance of forage and game. A trading station was maintained at Ogden.

In 1843 General Fremont made a scientific examination of Utah. His report was published in 1845, and read by Brigham Young, who had for some years contemplated moving with his people to the Rocky Mountains. This report led to the formation of a large body of pioneers. These reached Utah, under the leadership of Brigham Young, from July 21st to 24th, 1847. Utah is the only state in the Union that was systematically settled. To Brigham Young belongs the credit of this settlement. His colonies were amply provided with everything necessary for their growth and protection, and were composed of such people as would make themselves self-sustaining from the start. Special workmen were allotted to each colony, and were given the necessary tools belonging to their profession. They were well sustained by their people, for the watchword was " Support home industry.'

The plan of settlement consisted in clustering the people close together in towns. For the most part each place was divided into ten-acre, or (at a later date) smaller blocks. Each block was divided into four parts, and each family usually had one of these. In addition to this lot, the families took up farming land outside of the town. This has resulted in Utah being covered with little settlements, and with very few houses outside of the towns.

Since colonies depend much for their success upon easy communication with their base of supplies, good roads were

FIG. 44.

Frontier horse ranch on the western Utah desert. Notice at the left the corral made of poles stuck in the ground (with tops tied together by willows woven in).

built from Salt Lake City to all as rapidly as possible, and later the Deseret Telegraph was built to every important settlement, so that in case of danger the defensive forces of Utah might be brought together at the earliest moment. Of late years this line has given way to a very complete telephone system.

The early settlers experienced many hardships; the first was the destruction of their crops by grasshoppers. In the midst of their despair, before the

destruction was complete, myriads of seagulls appeared from the west, settled upon the grain, and rapidly devoured the insects. The people, in gratitude for what seemed an interposition of Providence, passed a law forbidding the killing of gulls. This law is still in force. During the California gold excitement the people oversold their crops and suffered greatly from privation

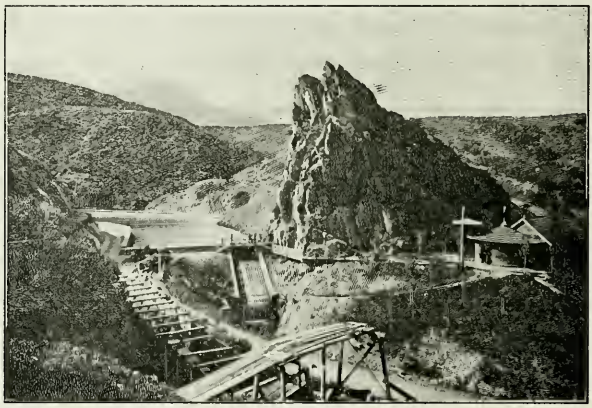

FIG. 45.

Parley's Canyon reservoir, with spillway near the rocks and flume in the centre. The cliff is composed of quartzite rock. The hills are covered with oak brush.

in the following spring. Many of them had to eat roots of the native plants to support life. The chief of these roots is the sego; it has a beautiful blossom, and has become the state flower.

When all the good land had been taken up around Salt Lake City, settlements sprang up along the base of the Wasatch Mountains both north and south. Bountiful had already been occupied in 1847. In 1848 the popu-

lation streamed northward to Centerville, Farmington, and Ogden. Then the tide set southward to Mill Creek. Next year Brigham Young began his "missions" by sending out parties to Sanpete Valley, Tooele, and Provo. Lynne, above Ogden, and some other hamlets were started near the existing settlements. In 1850 most of the immigrants swarmed into Utah Valley, a beautiful location, and founded Alpine, American Fork,

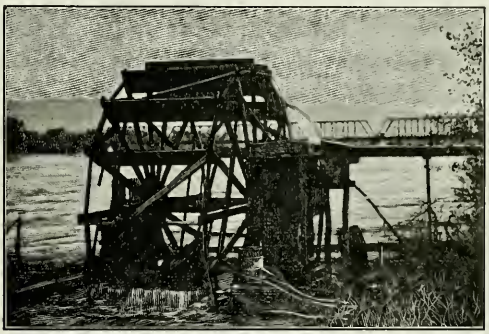

FIG. 46.

Irrigation wheel at Green River, with slanting buckets between the paddles, for lifting water to the ditches. The wheel is about thirty feet in diameter and is turned by the current of the river.

Pleasant Grove, Springville, etc. Other settlements sprang up around Ogden, such as Uintah and Slaterville. On the west Grantsville, in Tooele Valley, was settled. In 1851 hamlets began to spring up to the northward of Ogden, Willard being the most prominent. This same year "missions" were sent out to Parowan, Cedar City, etc. In 1852 the towns had extended as far south as the rim of the Great Basin (near Kanarra), while the larger towns had branched out into little settlements around them.

From 1853 to 1856 most of the settlements were made along the Weber, in Cache Valley, and in the St. George region.

The best land now having been taken up, it became necessary to go into the colder and mountainous regions and to take up the poorer clay lands of the valleys. From 1857 to 1868 the Weber was settled as far as Kamas, the Provo as far as Heber, and along the Sevier settlements arose for many miles. People even began to occupy the isolated mountain parks.

We find Utah was first inhabited by Indians, then by Mexicans and Indians, and then by systematic colonizing from the eastern states. This colonization was brought about for a definite purpose and wisely managed. Many hardships were experienced in the early years. These were due to the rigors of the climate, hostile Indians, and lack of easy communication with the outside world.

QUESTIONS. — Who were the first inhabitants of Utah? What people came next, and where did they settle? Why was Utah frequented by trappers and hunters? When did the first scientific expedition come to Utah? When did the pioneers arrive in Utah? How was Utah settled? How were the colonies provided? How were the towns laid out? How were the farms taken up? What was the cause of the hardships of the early settlers? Why were roads built early? Why was the Deseret Telegraph built? What followed it? Why are the sea-gulls protected? What happened during the California gold excitement? Describe the growth of the settlements? Why were settlements started on the poorer soils and in the cold and high valleys?

SEARCH QUESTIONS. — What evidence have we that Mexicans inhabited Utah? Find out what you can about Fremont's expedition. Also about the trip of the pioneers. Also the Indian wars. How were the various settlements made?

Routes of Transportation. — During the Indian and Mexican occupation, the chief highway was along the western

base of the Wasatch from the Snake River to the Colorado, by trail. Near Juab another trail followed up the Sevier River, and crossed over to northeastern Arizona. Another trail went eastward from the Weber to the Wyoming country. Immediately preceding its settlement, there were three wagon routes into Utah,— one over Emigration Canyon to Salt Lake City, one through the Weber

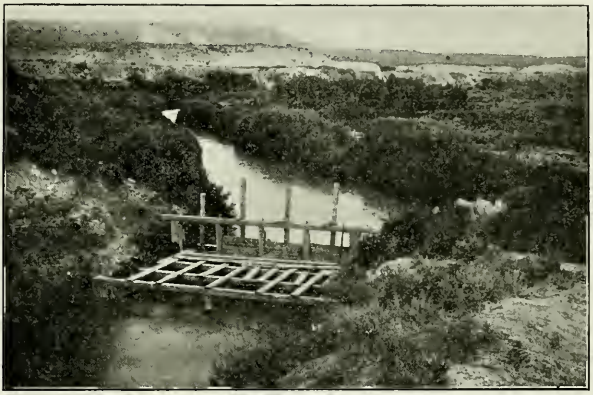

FIG. 47.

Salt Lake and Jordan Canal, with headgate to regulate the flow of the water. Willows on the banks of the canal; cottonwood trees farther back. The great bar at the point of the mountain in the background.

Canyon, and one into Cache Valley. Immediately after the settlement, good wagon roads were built in every direction.

In 1869 Utah began a still more rapid development, due to the completion of the Union Pacific Railroad. The Utah Central Railroad was soon built to Salt Lake City, and afterwards extended to Frisco. The American Fork Railroad went up that canyon to move the ores from

the Miller mine. The Bingham Canyon Railroad was built to Bingham, and the Wasatch and Jordan Valley to Alta to haul the ores of those camps. The Utah Northern Railway ran to Idaho to furnish transportation for the great valleys of northern Utah. The Utah and Nevada Railroad was constructed westward to Terminus to tap the western valleys and mines. By this time the great natural highways of distribution had been occupied by railroads, and had reached all of Utah except the Sanpete and Sevier valleys. All followed old wagon roads, which were built for similar purposes, and all centred in Salt Lake City. In 1883 the Rio Grande Western Railroad was finished across the deserts of eastern Utah and over the coal fields to Salt Lake City. Later this road has occupied the Sanpete and Sevier valleys, and has built branches up the Provo and over the mountains from Salt Lake City to Park City. This line and the Union Pacific have also built to Eureka, and are contemplating opening the southern and western part of Utah by through railroads.

We find Indian trails early established along the natural routes of transportation. These were afterward utilized by wagon roads and finally occupied by railroads.

QUESTIONS. — Describe the chief highways during the Indian and Mexican occupation. What were the early wagon routes in Utah? What routes of transportation were built after 1869? Describe them. What towns would you pass through in going from Ogden to Grand Junction? What from Ogden to Frisco and Modena? How would you reach Provo? Alta? Manti? Marysvale? Mercur? the Mammoth mine? Park City? Heber? Sunnyside?

SEARCH QUESTIONS. — How did the Indians first make their trails and discover the best routes? How did the pioneers find out the best wagon routes? Describe the various kinds of bridges in your region, from the smallest to the largest, and how they are made.

CHAPTER VIII

GOVERNMENT

Political History. — At its settlement Utah was part of Mexico, but in the year 1850 having been ceded to the United States, was erected into a territory with Brigham Young as governor. It contained 225,000 square miles. In 1869 it was reduced to its present size, which is 84,970 square miles. January 4, 1896, it was admitted as a state.

System of Government. — When Utah was a territory it had a form of government which was established by Congress. Its legislature could pass laws, but the Governor, who was appointed by the President of the United States, had the power of absolute veto on all such legislation. In addition, Congress could annul any laws passed by the Legislature and the Governor.

Before Utah's admission to the Union, Congress passed an Enabling Act whose terms were to be fulfilled by the proposed constitution of the new state before it could become a state. A constitution was duly adopted, approved by Congress, and Utah declared a state.

The Constitution guarantees to every citizen certain inalienable rights. All persons who are neither idiots, insane, nor convicted criminals, and are over twenty-one years of age, are voters provided they are citizens of the United States, have resided in the state for a year, in the county for four months, and in the precinct for sixty days

previous to the time of voting. All have equal rights without regard to sex or color. All ballots must be secret. General elections shall occur every two years on the first Tuesday following the first Monday in November, and all officers shall take office on the second Monday in January after their election.

State Government. — In order to conduct the affairs of a state properly, such as to raise money for the expenses of management, to educate the children, to make laws, to punish criminals, and to have all things in systematic order for ease in operation, it has been found best to separate the government into three independent departments: the law-making or legislative, the operating or executive, and the judicial or system of courts for interpreting the laws. Though this system seems to be found only in the management of the state as a whole, it really pervades the county and city management as well, and is also found in all business establishments of importance.

Legislative. — Utah's participation in the management of the United States consists of two senators who are elected by the Legislature for six years (salary $5000), and one representative elected by the people (salary $5000) for four years, all of whom go to Congress and take part in the making of all legislation passed by Congress.

The state Legislature consists of a Senate and House of Representatives. The Senate is composed of eighteen members. This number must never exceed thirty. The senators are elected by the people from senatorial districts, for four years, and half are elected every two years. A senator must be twenty-five years of age, a resident of the state for three years, and a resident of the district for one year. The House consists of forty-five members.

The number of members must never exceed three times, nor fall below twice, the number of senators. These legislators are apportioned to the various districts according to the population. The powers of the Legislature consist in making laws, approving or rejecting appointees of the Governor, and impeaching and trying the general state officers for misconduct in their offices. The sessions shall never exceed sixty days in length. The Governor may veto any bill passed, but the Legislature may pass it over his veto if two-thirds of each house so vote. All bills which are not disapproved by the Governor within five days after being passed become laws unless it is at the end of a session, when ten days are allowed. It case of the trial of any state officer for misconduct in office the House must prosecute and the Senate must sit in judgment. If two-thirds of the Senate vote for conviction, the officer on trial is deposed from office. When the Governor is on trial, the Chief Justice of the Supreme Court presides.

Executive. — This department consists of the various state officers and boards.

Governor. — The Governor is the chief officer in the state, and supervises the work of all the other officers. He represents the state in all its relations with other states, signs bills of the Legislature before they become laws, issues election and other proclamations, offers rewards for the arrest of criminals, and appoints officers to fill vacancies.

Secretary. — The Secretary of the state controls all papers of the Legislature, keeps the seals, issues incorporation papers, certifies elections, and has the care of the Capitol buildings. (Salary $3000.)

Auditor. — The Auditor keeps all the state financial accounts. (Salary $2000.)

Treasurer. — The Treasurer pays out all moneys. (Salary $1500.)

School Superintendent. — This officer has general charge of the schools of the state. (Salary $1800.)

All the above are elected to office by the people.

Coal Mine Inspector. — The Inspector has charge of the inspection of coal mines. (Salary $2000.) This officer and all that follow are appointed by the Governor.

Statistician. — The Statistician has charge of the collection of statistics of all kinds pertaining to the state. (Salary $1500.)

Adjutant General. — (Salary $500.) The state militia is commanded by this officer.

Engineer. — The State Engineer has the care of all water of the state, makes surveys, estimates on all kinds of irrigation projects, and collects all irrigation data. (Salary $2000.)

Fish and Game Commissioner. — This officer has the oversight of all matters pertaining to the protection and propagation of fish and game. (Salary $1000.)

Dairy and Food Inspector. — This official serves two years. (Salary $600.)

Bank Examiner. — This officer holds his position at the pleasure of the Governor, and examines and reports on the condition of the banks of the state. (Salary $1200.)

Collector of Taxes on Cars. — This officer attends to the taxes on cars of railroads within the state. (Salary $300.)

The following are the state boards. All members are appointed to office by the Governor and serve four years, except as otherwise noted.

State Board of Equalization. Four members (salary $400).

Examiners. Governor, Secretary, Attorney-General.

Health. Seven members. Term seven years. Local boards may be appointed by the cities, town trustees, etc. These boards shall consist of three members.

Horticulture. Three members. One each in the three districts. The first district shall consist of all counties northeast and west of Salt Lake County; the second of Utah, Carbon, Juab, and all counties south to and including Grand and west to Millard; the third of the remaining southern counties.

Labor. Three members. (Salary $4.00 per day.)

State Library. Governor and members of the Supreme Court.

Silk. Five members to serve five years. (Salary of Secretary, $900.)

Loan. Governor, Secretary, Attorney-General.

Pharmacy. Five members to serve five years.
Dental. Five members.
Land. Governor, Secretary, and five members to serve two years.
D. A. & M. Society. Twelve directors.
Corrections. Four members and the Governor.
Insane Asylum. Governor, Treasurer, Auditor.
Deaf, Dumb, and Blind. Five members.
State University. Nine Regents.
Agricultural College. Seven Trustees.
Education. State Superintendent of Schools, Presidents of the University and Agricultural College, and two members.
Reform School. Three Trustees.
Art. Seven members.

Judicial. — The judicial department of government is represented by the United States District Court with one judge who serves for life, by the United States Marshal and United States District Attorney, and minor officers. This court has jurisdiction over all matters between the state of Utah and other states, and over all legal matters between citizens of Utah and those of other states. It has power over all violations of United States laws.

For trials of state officers, see Legislature.

State Supreme Court. — This consists of three members who serve six years. Each judge must be thirty years old and a resident of Utah for five years. They are elected by the people. Minor officers of this court are Clerk, Reporter, and Bailiffs. (Salary of judges, $3000.) This court has jurisdiction over all cases at common law and state laws. Appeals can be made to the Supreme Court from all district courts. There is no appeal from the decisions of this court where the state laws are concerned, but appeals can be made to the United States Supreme Court in other matters involving a United States

treaty, statute, or practice. The Supreme Court has no jurisdiction over cases tried in the United States District Court.

State District Courts. — There are seven district courts in Utah. One judge elected by the people every four years presides over each district except in the Salt Lake District, where there are three judges. He appoints his own stenographer. He must hold court at least three times each year at each county seat in his district. He must be twenty-five years old, and be a resident of the state for three years. This court has jurisdiction over all cases at common law and state law, but there is an appeal allowed from its decisions to the Supreme Court. The Attorney-General is elected for four years. (Salary, $2000.)

The right of trial by jury is not denied except in petty cases. A jury shall consist of twelve persons in all capital offences, and a unanimous verdict must be returned. In all other cases the jury shall not exceed eight persons. In criminal cases this jury must reach a unanimous verdict; in others three-fourths must agree. In civil cases and misdemeanors it may be less than eight by agreement of both parties to the case. In justices' courts it must not exceed four persons, and may be less by agreement. A Grand Jury shall consist of seven persons. Its duties are to inquire into violations of law and bring indictments against offenders in grave cases if five members of the jury agree as to the offence. But prosecutions may be instituted by the courts without indictment by a grand jury.

County Government. — The legislative department of county government is represented by the Board of County

Commissioners, which consists of three members elected by the people. They pass such regulations as the proper conduct of strictly county matters demands, and fix the salaries of officers, determine the taxes to be levied, etc. The executive department of county government is represented by the treasurer, recorder, auditor, attorney, surveyor, assessor, school superintendent, school trustees, coroner, etc. These are all elected by the people. The judicial department of county government is represented by the District Court and by justices of the peace, sheriff, and constables. The county commissioners are required to divide the counties into justices' precincts.

City Government. — The legislative side of city government is represented by the City Council. This bears the same relation to the Mayor that the Legislature does to the Governor. It can pass any regulations desired for the management of city affairs, but subject to the veto of the Mayor. The veto can be overruled by a two-thirds vote. It also has the confirmation of all city officers appointed by the Mayor. In cities of the first class the Council consists of fifteen members, in second-class cities of ten members, and in third class of five members. All city officers serve two years.

The executive department of city government consists of the Mayor, Recorder, Treasurer, who are elected by the people, and in cities of the first and second class by an Attorney, School Board, and Auditor; these are also elected. Among the many officers appointed for city positions are the police, water, fire, health, streets, and public works boards; other officers are the surveyor, and engineer, superintendent of parks, building inspector, dog tax collector, etc. The judicial department of city government is represented by the higher courts, by the city court or city justice. There are two judges of the city courts who are elected by the people, must be twenty-five years

old, and receive a salary of $2500 each. These judges have jurisdiction over all matters concerning city ordinances, and all cases involving not over $500. They decide all cases without juries where the fine is not over $50 nor the imprisonment exceeds thirty days. This court is found only in cities of the first class. In other cities the city justice has jurisdiction over all matters pertaining to city ordinances, and all other cases not involving a fine of over $300 nor imprisonment for longer than six months.

CHAPTER IX

CITIES AND TOWNS

Exclusive of Mining Camps.—In the region west of the Wasatch valleys there are few settlements. The chief of these are Ibapah in the Deep Creek Mountains, Fish

FIG. 48.

Method of irrigating a vineyard at St. George; water just beginning to flow down the rows. St. George Temple in the background.

Springs in the Fish Spring range, and the Hawaiian colony in Skull Valley. These settlements raise hay and grain. Tooele Valley, which lies directly west of Salt Lake Valley, has the two thriving settlements of Tooele and Grantsville, which raise much produce and fruit, and supply the adjoining mining camps. Rush Valley, which

lies directly south, and is a prolongation of Tooele Valley, has two settlements, St. John and Vernon, which raise similar products.

Cache Valley. — This is one of the most fertile in Utah, and along with Sanpete divides the honor of being the granary of Utah. There are many towns in this valley. All of them are of good size. The soil is fine and has but little alkali. The products are fruit, especially berries,

FIG. 49.
Lehi beet-sugar factory.

cherries, and the like, root crops, hay, and grain. Logan is the chief city. It is beautifully situated at the mouth of the Logan River in the shadow of the Wasatch, and has fine drainage, soil, and scenery. In 1900 the population was 5451. It has many business houses, and is the seat of the Agricultural College of Utah, the Logan Temple, Brigham Young College, and several schools and churches. There are two knitting factories, one nursery, and one sugar factory. The Hercules Power Company is located here, and develops 4000 horse power. Other towns are Providence, Millville, Paradise, Hyrum, Wells-

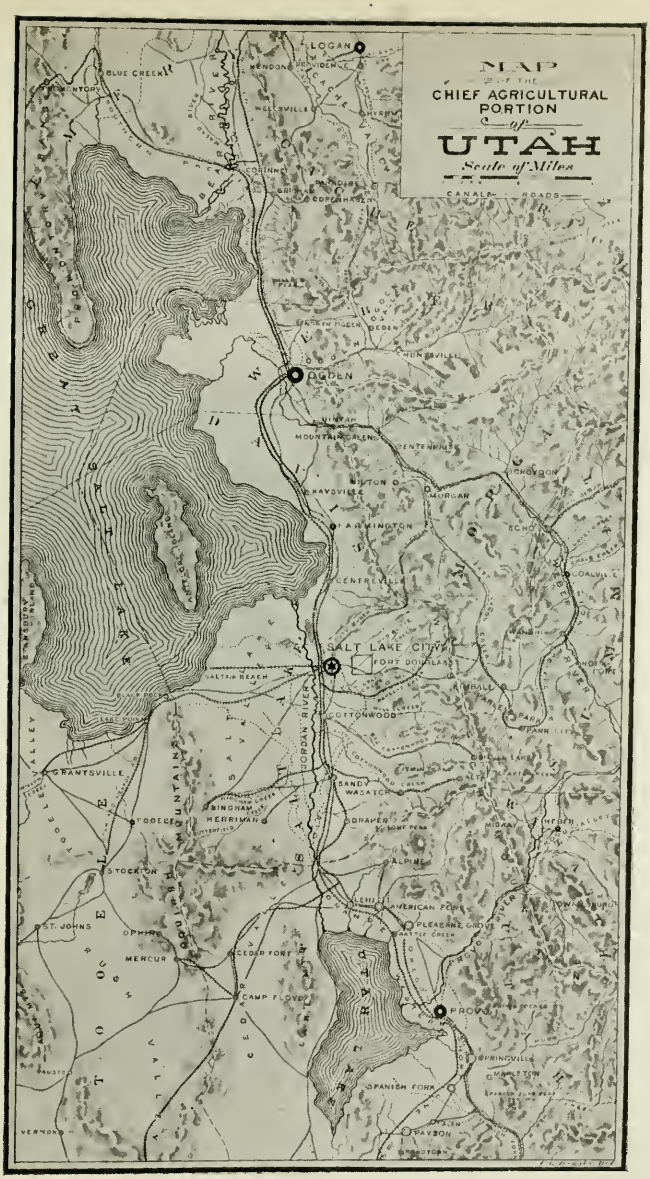

FIG. 40. facing p 106

Locate the canals on this map, railroads, wagon roads, desert, lakes. Trace the county lines. Describe the valleys and trace their water sheds. What is the capital? Leading cities? Trace the mountain ranges.

ville, Mendon, Trenton, Clarkston, Richmond, Smithfield, and Hyde Park. The Oregon Short Line Railroad traverses this valley.

Malad Valley.—This lies just over a low range west of Cache Valley along the Malad River, and has several towns. Its products are the same as Cache Valley.

FIG. 50.

Provo woolen mills, with cloud-capped Wasatch in the background. Irrigating ditch in the foreground.

Bear River Valley.—This raises much hay and grain and some fruit. The soil is very fertile, but the climate is cold. The leading towns are Randolph and Laketown.

Lake Shore.—The land in this region is as fertile as any in Utah, and because of its low elevation is excellent for fruit. The principal products are fruit, root crops, hay, and grain. The region has such good railway facilities that the crops raised are shipped in all directions. The principal towns on the north are Corinne, Brigham City, and Willard. The principal towns on the south are Farmington, Kaysville, Centreville, Layton, and Bounti-

ful. Ogden is the largest city, and lies in the centre of the region. It is the second city in size and importance in the state, and is a great railway centre. It is beautifully situated on the Weber and Ogden rivers at the foot of the towering Wasatch. Unlike most of the cities of Utah, Ogden has an abundant water supply both for irrigation and power, and is quite a manufacturing centre. Its people are very aggressive and loyal to their city. The population in 1900 was 16,313. It is well supplied

FIG. 51.
Logan and Caché Valley, with the Temple on the left.

with churches, private and public schools, banks, hotels, business houses, and parks. There are a number of fine summer and health resorts, such as Glenwood Park, the Hermitage, Malan's Heights, Winslow Inn, and the famous Hot Springs. In Ogden Canyon is one of the greatest power dams in Utah. It furnishes electric power for all towns from Ogden to Salt Lake City, and is the most expensive in the state. Ogden is the seat of the Deaf and Dumb Institute, Reform School, and Carnegie Library. It is supplied with waterworks, light and gas plants, and paved streets. The principal manufacturing establish-

ments are the beet-sugar factory, woolen mill, laundries, flour mills, brewery, canning factories, creameries, broom factory, brick yards, candy, box, vinegar, and cracker factories. The towns south of Ogden do much market gardening for Salt Lake City. All this region is traversed by railroads.

Salt Lake Valley. — This is the most populous valley in the state. It is noted for its manufactures, commerce,

FIG. 52.

Ogden. The Wasatch in the background, the Weber River flowing under the bridge. The dark bushes in the foreground are the squaw bush.

fruit, and vegetables. Salt Lake City (Figs. 53–56) is the capital and chief city in the state. It has always been the great financial, religious, and educational centre, not so much because of its natural facilities, in which, on the whole, it is second to none, but because it was first made the great political centre and has been fostered ever since. In early times the only feasible route from the great plateau country of Wyoming, over which were all the overland trails, was through Salt Lake Valley. In addi-

tion, the early discovery of mineral in Bingham and Little Cottonwood made Salt Lake Valley the natural smelting point for those camps. During these early years the smelting industries of the valley had secured such a lead that not even the development of such great camps as Tintic and Frisco, and the discovery of coal in the Coal Range southeast of Provo, could take from Salt Lake

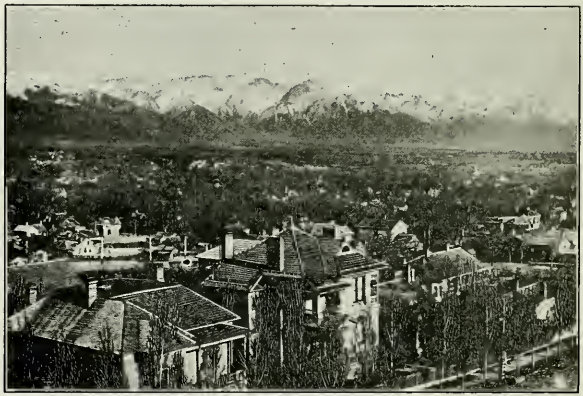

Fig. 53.
Salt Lake City and the Wasatch.

Valley its lead in smelting. Perhaps the chief factor in the development of Salt Lake City was the fact that it was the centre of the Mormon Church and of all the colonizing projects by which settlements were established and roads built in all directions from it.

The natural advantages of Salt Lake City are its beautiful situation on the southern slope of a spur from the Wasatch, with its consequent warm climate and protection from the wind; its proximity to Great Salt Lake, with its delightful bathing facilities; and its nearness to the

loftiest portion of the Wasatch Mountains, with their magnificent scenery and delightful summer resorts. The death rate is only 13 per 1000. For many years Salt Lake City was the centre of overland travel, but the building of the Union Pacific Railroad through Weber Canyon took from it this advantage. This was partially restored by the Rio Grande Western Railroad, and fully compensated for by the completion of the Park City and the Utah and Nevada railroads. The extension of the Los Angeles Railroad to the Pacific will again make Salt Lake City the centre of overland travel. The Zion's Coöperative Merchantile Institution, which is the greatest business establishment in Utah, was early organized for making Salt Lake City the great distributing centre in the mercantile line. The larger part of the business enterprises of the state have originated here.

The city is supplied with water of fine quality from City Creek, Emigration, and Parley's, as well as by a canal from Utah Lake. This water is carried by a very efficient water system in pipes throughout the city, and also runs down the gutters and irrigation ditches around and through every block. The drainage is excellent by nature, because of the slope, and has been made more efficient by a thorough system of underground sewers. The city is laid off for the most part in blocks of ten acres each, with hundred-foot streets and sixteen-foot sidewalks on each side. It is a common feature of Utah towns to be laid out in this way, with streets running according to the points of the compass, and it gives them an air of regularity and openness which is much admired by Eastern people. In addition the sides of the gutters have been planted with shade trees. From a distance the city

appears to be situated in a grove of beautiful trees. The principal streets are paved with asphalt. The city has eighty miles of street car lines, which are supplied by electric power and many modern cars, which give rapid transit to all parts.

The chief attractions of Salt Lake City are its delightful climate, hot and warm springs, commercial and indus-

FIG. 54.

City and County Building, Salt Lake City, built of Utah gray sandstone.

trial advantages, and educational facilities. It is lighted by electricity and gas, is furnished with electric power from Big Cottonwood and Ogden for running its machinery. It has an extensive telephone system, is the centre of six railroads, and is the site of the State University (Fig. 56), the Mormon Temple (Fig. 55), Tabernacle, and Assembly Hall, the City and County Building (Fig. 54), the State Fair, four colleges, several academies, and many churches. It has very many fine buildings, both

mercantile and residence. It is well supplied with hospitals. Though the smelters are really outside of the city, they properly belong to it, as they are operated from it. These are the great Germania, the United States, and Bingham Consolidated. Among the attractions adjoining Salt Lake City are City Creek Canyon, Fort Douglas, which

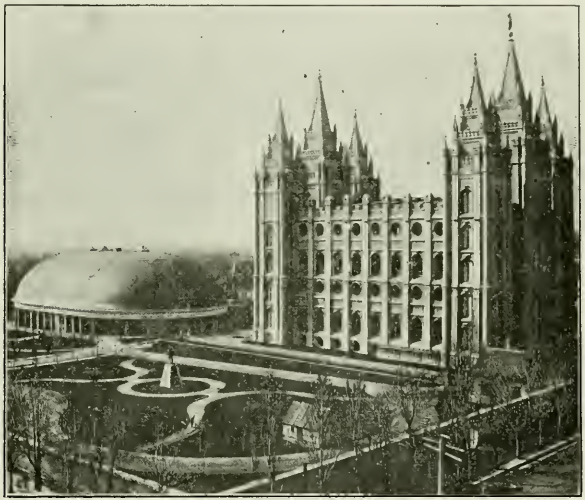

FIG. 55.

Temple and Tabernacle of the Latter Day Saints, Salt Lake City. The Temple is built of Utah granite.

is a beautiful government post on the east side of the city, several resorts in Parley's Canyon (Fig. 45), Brighton's (Fig. 9), and Little Cottonwood in the heart of the Wasatch. The manufaturing industries of the city are varied and extensive, the chief ones being printing establishments, shoe factories, foundries, breweries, railway shops, and smelters, employing over 9000 people,

and doing a business of about forty millions. The city is about three miles wide by five miles long, and in 1900 had a population of 53,531. The bank clearings are $180,000,000, and jobbing trade, $27,000,000.

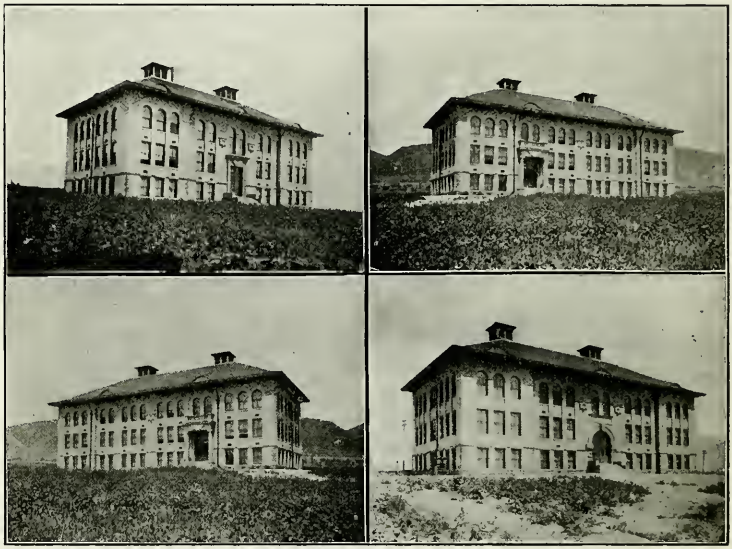

FIG. 56.
State University, Salt Lake City.

The other important towns in Salt Lake Valley are Mill Creek, Murray, Brighton, West Jordan, Bingham Junction, Draper, Riverton, and Herriman.

Utah Valley. — This is the most beautiful valley in the state and is well watered. The chief products are fruit, hay, and root crops, especially beets. The leading town is Provo, a city of about 6000 inhabitants. Like Ogden Provo nestles close under the Wasatch. It is beautifully

situated on the Provo River, and is surrounded by a rich farming and fruit country. Provo is the seat of Brigham Young Academy (Fig. 58), one of the largest schools in the state, with an attendance of more than 1,000. It also has a large woolen mill (Fig. 50), using 700,000 pounds of wool yearly, the product being valued at $200,000. There are two main railroads, and a branch road running up the Provo River to Heber. It has a foundry, two flour mills, soda-water works, knitting factory, candy factory, pottery, creameries, lumber mill, stone-cutting works, etc. It is in easy reach of fine summer resorts along the Provo, and also has a bathing resort on Utah Lake. The State Insane Asylum is here. The Telluride Power Company is located near Provo, with a capacity of 7500 horse power.

The other leading towns in this valley are Springville, with a branch beet-sugar factory, Lehi, where the great beet factory (Fig. 49) is located, American Fork, Pleasant Grove, Payson, etc. Spanish Fork has a shoe and broom factory. Goshen is the principal town in Goshen Valley. The principal products are hay, grain, and fruit.

Juab Valley. — The principal town is Nephi, which raises fine fruit, grain, and hay, has large salt and gypsum deposits and a plaster of Paris factory. It has two railroads. Stock raising is one of the principal industries.

Weber Valley. — There are many little settlements along this valley. The principal towns are Morgan and Coalville. At the latter place much coal has been mined. The principal occupations of the people are the raising of stock, hay, and grain.

Provo Valley. — This also produces much hay and grain. The principal towns are Heber and Midway.

Spanish Fork River. — This region is traversed by the Rio Grande Western Railroad, and has a number of settlements which raise stock and grain. Clear Creek at the head of the valley was once quite a coal-mining camp.

Thistle Valley. — Here is an Indian settlement called Indianola, where they raise hay and grain.

Sanpete Valley. — This is one of the greatest valleys in the state. It produces large quantities of hay and grain, and some fruit is raised. The settlements are unusually large and thrifty. The principal towns are Manti and Mount Pleasant. The former has an electric light plant, flour mill, two railroads, and good coal mines near by. Here is the Manti Temple. There are large deposits of oölitic sandstone (a rock composed of minute shells) in the vicinity. The Temple is made of this stone. Most of the people of Sanpete Valley are also engaged in sheep raising. Other leading towns are Moroni, Fairview, and Ephraim.

Sevier Valley. — Though some fruit is raised in the lower part of this valley, the principal products are hay, grain, and some beets. The principal town is Richfield, which supplies the mining camp of Gold Mountain. Salina is another thriving town, having large salt, gypsum, and oölitic sandstone deposits. Monroe is the second town in the valley, is one of the most beautifully situated in the state, and is destined to become a great health resort because of its mineral springs and climate. Gunnison is also a thriving town as well as Elsinore, Joseph City, etc. The upper Sevier Valley contains the beautiful little settlement of Marysvale, which is the outlet of the Marysvale mines, and will become a health resort. Other towns are Junction, Circleville, and Panguitch. The latter is the leading town in the upper valley, and raises much hay, grain, and

stock. The lumber region above is worked by the people of this town. Grass Valley also produces hay and grain. Its principal towns are Burrville, Koosharem, and Coyoto.

Beaver River Region. — There is a narrow area lying on the western base of the range from where the Sevier River cuts through the mountains to Kanarra. This country has knots of settlements scattered along the range. The first two towns on the north are Deseret and Oasis, which are watered by the Sevier River, raise hay and grain, and are the supply points for the Fish Springs region. Below these and near the mountain is Oak Creek. Farther south are Holden and Fillmore. The latter was once the capital of the state. West of Mount Belknap comes Beaver Valley, a fruit and grain raising region, whose principal town is Beaver. This has an academy and is quite a place. Parowan is the next large town lying near the southern end of this region. Cedar City, not far away, is one of the leading towns. Both raise much fruit, hay, and grain, and the latter has large deposits of coal near by. Milford, for a long time the terminus of the railroad, lies west of Beaver in the lower end of Beaver Valley. Around the rolling hills near Pine Valley and near the iron mines are Iron Springs, Iron City, Hamlin, Pine Valley, etc.

St. George Region. — Here they raise figs, almonds, and many other fruits. Cotton and canaigre root are grown. The people make much wine. Considerable hay and grain are raised for home consumption. The principal town is St. George, which is the seat of the Mormon Temple (Fig. 48). Other towns are Washington, Rockville, Springdale, etc. This region is called the "Dixie country."

Settlements along the Eastern Rim of the Great Basin. — On the upper Virgin before we come to our region proper

are a number of small settlements raising fruit and stock. Just south of this is Kanab, which also raises fruit and stock. On the head of the Pahria are several small settlements. On the head of the Fremont River are several others such as Loa, Thurber and Teasdale. All raise hay and grain. There are also several settlements on the lower Fremont River. Hanksville and Cainville are some of them (Fig. 39). Opposite Salina are still other settlements along the creeks which come out of the Coal-Range. These, like the settlements below, raise hay and grain and are much interested in stock. The leading towns are Castle Dale, Huntington, Orangeville, Ferron, etc. On the Price River are several towns. The leading one is Price, which is the supply point for the Uinta country. Castle Gate is the coal-mining town, while Sunnyside, another similar town, lies farther south.

Uinta Region. — This is a great Indian reservation. The principal towns are Ashley and Vernal, where they raise considerable hay and grain. The principal occupation of the people is stock raising, farming, and trading with the Indians. They have considerable coal and asphalt in this locality.

Green River Region (Figs. 4, 46). — This has few settlements. Green River on the extreme west and Moab on the east are admirable fruit sections and also raise cotton. The latter has the finest fruit in the state, and is the supply point for the La Sal Mountains, where they mine considerable gold, copper, and uranium.

Southeastern Utah. — The town of Bluff is located on the San Juan River and is chiefly engaged in stock raising, though considerable fruit, hay, and grain are raised.

QUESTIONS. — Describe the settlements in the region west of the Wasatch valleys. What are their products? Describe Cache Valley. Describe its soil and products. Describe its chief city. What can you say of Malad Valley? What can you say of Bear River Valley? Describe the Lakeshore region, its chief products and manufactures. What can you say of Ogden, its products and manufactures? Describe Salt Lake Valley and all its industries. What can you say of Salt Lake City? What are its natural facilities? Why is it a financial, religious, and educational centre? Describe its chief industries. Describe its resorts. Describe its water system, street system, street car system. What are its chief attractions? Describe Utah Valley and its products. What can you say of its leading city? Describe Juab, Weber, Provo, Spanish Fork River, and Thistle valleys. Describe San Pete Valley and its products. What is its chief town? Describe Sevier Valley and its products. What can you say of its leading towns? What can you say of the Beaver River region and the country south to Kanarra? What can you say of the St. George region? What can you say of the Uinta, Green River, and southeastern Utah regions?

CHAPTER X

EDUCATION

Education. — Very soon after the settlement of Utah the people began their educational system. For many years their isolation from the outside world made progress in this direction slow, notwithstanding the Deseret University

FIG. 57.
Agricultural College at Logan.

was organized in early years and did much good. Of late years the educational system has developed greatly and much enthusiasm is shown in improving the school work. In 1890 a law was enacted by the state, requiring a uniform course of study, andthe various educational institutions have been brought into a harmonious system working for a common end. High schools have been organized in many

of the leading towns for giving advanced instruction. The State University at Salt Lake City has been greatly enlarged and supplied with libraries and suitable apparatus. Connected with it is the State Normal School, with its branch at Cedar City. The State Agricultural College is located at Logan (Fig. 57), with an additional experiment station in the St. George region, and is doing much good in educating communities along practical lines.

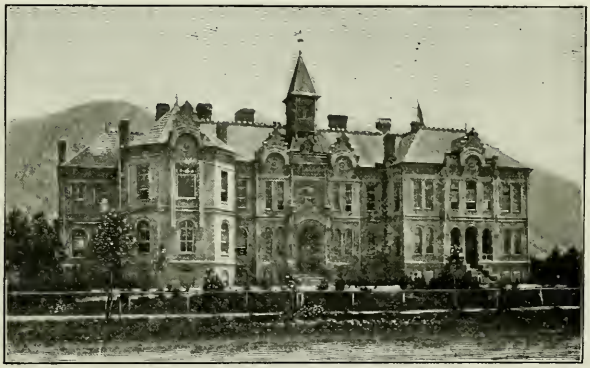

FIG. 58.
Brigham Young Academy at Provo.

The Mormon Church has also developed an educational system of its own which is now highly organized, with the Latter-Day Saints University located in Salt Lake City, Brigham Young College at Logan, Brigham Young Academy at Provo, and a number of other academies scattered throughout the state. These institutions are growing rapidly in attendance and usefulness to their people.

The other religious denominations in Utah have also their sectarian schools and colleges. The Presbyterians

have Sheldon-Jackson College in Salt Lake City and several academies throughout the state. The Congregationalists have two academies. The Catholics have one college in Salt Lake City and several academies in the city and other parts of Utah. The Episcopalians have several schools.

The state school system is much the same as that prevalent in other states. There is a State Superintendent of schools who has

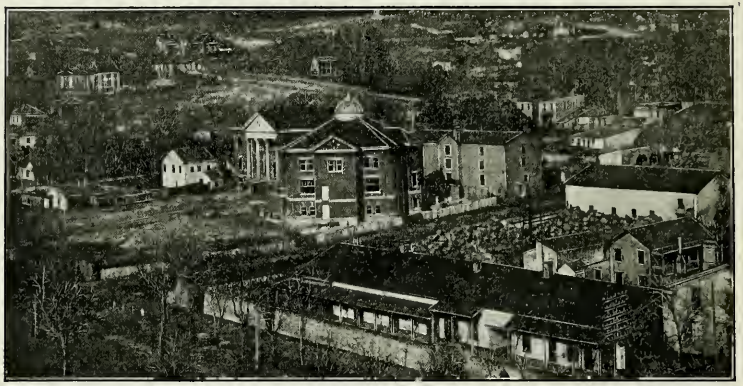

FIG. 59.

Latter Day Saints' University, Salt Lake City, partially completed. The old tithing building is in the foreground.

general oversight of all the schools in the state, collects school statistics, and publishes regularly all facts of general interest regarding the schools. He is elected by the people for four years at a salary of $1800 a year. The State Board of Education consists of the State Superintendent, President of the University, President of the Agricultural College, and two other members appointed by the Governor and approved by the Legislature. The appointees hold office for four years. This Board issues state high school and grammar diplomas, to persons over twenty years of age, which are good for life if the persons receiving them have had two years of successful experience

and do not cease to teach for a longer period than five years. They also issue state certificates which are good for five years. Graduates of the State Normal also can teach without being reëxamined, under certain conditions.

Once in five years the state adopts official text-books. The committee which selects these books is composed of the State Superintendent, President of the State Normal, and the County Superintendents.

Each county has a County Superintendent who has supervision of all county school matters, much the same as the State Superintendent does of the state at large. He is elected for two years. The County Board of Examiners is composed of the Superintendent and two members appointed by him. This Board issues certificates good for a year. Each county must hold one School Institute every year which shall not continue less than two nor more than ten days. All teachers are required to attend this Institute. Cities of the first and second class (those having a population of 5000 or more) are exempt from the control of the County Superintendent. They are managed by City Boards of Education. In cities of the first class (20,000 population or over) there are ten members of the Board elected, two from each precinct (all cities of first and second class are divided into five precincts). They hold office for four years. Half of them are elected every two years. In cities of the second class there are five members of the Board who also hold office for four years. This Board directs all city school matters, adopts city text-books, etc. It elects a City School Superintendent who holds office for a year. The City Superintendent selects two persons who with him form the City Board of Examiners. This Board issues certificates to city teachers. The County Commissioners separate each county into school districts (outside of the cities of the first and second class). Over these districts three trustees preside, who are elected by the people and hold office for three years. One is elected each year. They select teachers and have general supervision of the schools in their district.

All children over six and under eighteen years of age are required to attend school. Each city can levy a tax not to exceed $5\frac{1}{2}$ mills on the assessed property of the city for the support of its schools. The county tax must not exceed 5 mills. The district tax must not exceed 3 mills. The state tax is usually 30 mills. The state educational institutions all have their boards appointed by the Governor and

approved by the Legislature and hold office for four years. The University has nine regents, the Agricultural College seven trustees, the Reform School three members, the Institute for the Deaf, Dumb, and Blind three members. The Agricultural College must hold at least one Farmers' Institute in each county a year.

The course of study adopted by the state has three departments, primary, grammar, and high school. The primary covers a beginner's grade and four other grades or years of study; the grammar covers four years or grades; the high school covers two years. Nature study covers all the grades, and in the seventh and eighth grades adds physiology. The pupils in each grade are expected to study in their seasons plants, animals, minerals, weather, and geography so far as it applies to nature study proper. Language, grammar, reading, spelling, arithmetic, drawing, music, and physical culture are studied through all the grades; phonics continue through four grades, penmanship through six, geography begins with the fourth grade, and history with the sixth. The high school course completes arithmetic, algebra, civil government, physiology, bookkeeping, penmanship, plane geometry, elementary physics, elementary botany, elementary zoölogy, and continues English and history.

The Salt Lake City school system follows the state system, but divide each grade into "A" and "B," with promotions each half year. Its high school course covers four years, and fits for the sophomore year in the State University and other colleges. The sessions begin at 9 A.M. and close at 3.10 P.M. The school year is thirty-eight weeks long. Promotions shall be made when the general average of a pupil is 70% or more in every study, if any study is less than 70% then the average of all other studies must be 75%. Pupils standing 90% or over can have special promotions every three months.

SUMMARY

Utah is the eighth state in the Union in size. Being the only state which was settled systematically and under one direction, its cities and towns have features peculiarly their own. The mineral resources are very great, the state being among the leaders in the product of coal, sil-

ver, lead, and copper. There are very large deposits of salt and building stone. The lofty mountains furnish through the streams sufficient water-power for all purposes. The scenery is magnificent, and the climate so varied that even the most fastidious ought to be satisfied. Great Salt Lake and the mountains are famous resorts both for residents and tourists. Utah is a land of irrigation, and occupies a leading position in the central West in fruit and farm products. Being centrally located between the Mississippi and the Pacific, the state has become the commercial centre of the inter-mountain region, and the great smelting point of the region west of the plains.

QUESTIONS. — When did the educational system in Utah begin? Has there been any improvement since? Mention the state institutions and their locations. What can you say of the educational system of the Latter Day Saints? What can you say of the other religious denominations?

SEARCH QUESTIONS. — Secure a copy of the state law establishing the present educational system, and find out every detail. Who are the officers and teachers, and what are the schools of your county? What method is being used to beautify your school and the grounds, and what can be done to make them attractive places? Can you give any reason why churches and schools are generally without beautiful grounds or attractions?

GENERAL REVIEW QUESTIONS

PHYSICAL FEATURES. — When did Utah first show land above the sea? When was all of Utah above the sea? What forces are antagonistic to each other? Trace the boundary of Utah at the end of the Coal Age. When was our coal formed? How? What ancient lakes were in Utah? When was the Great Basin Divide formed? What about the ancient climate? How does the Wasatch differ from the Coal Range? What are the chief mountains in the state? What are the leading valleys, and in what do they excel? Where are the

great plains? Where are the great canyons? Why? What causes volcanoes and hot springs? Explain erosion and deposition. What causes cloudbursts? What kind of canyons do water and ice make? What governs the rapidity of erosion? Do deserts depend on chemical changes for their character? Can they be redeemed? What effect have glaciers? What causes scenery? How are minerals grouped? What causes mineral veins? What was the greatest area of Great Salt Lake at any time? What is it now? What is the percentage of salt in the water? How does the surface vary? What effect does irrigation have on it? What is peculiar to Utah climate? What is the climate of St. George? Salt Lake City? What is the general soil of Utah?

Life

Describe the life zones and their limits, and characteristic animals and plants. How did the present flora of Utah come to be as it is? What devices do plants use for protection against enemies? Climate? What is peculiar to the plants of the St. George region? Salt Lake desert? Wasatch valleys? What is the timber of the high mountains?

Industries

What are the two leading industries in Utah? Name the leading mining camps. Gold mining camps. Lead camps. Silver camps. What camps have wet mines? What professions are dangerous? Where is iron found? What camp has silver in sandstone? What sections produce the most hay? Grain? Fruit? Cotton? Sheep? Where is beet sugar made? What have dairies? Canning factories? What has the most manufactures of all kinds? What kinds of irrigation are used in Utah? Where is stock raising done?

Settlements, Cities, and Towns

How were the settlements of Utah made? Where located, and why? How connected, and why? Describe the transportation routes and their benefit to the various sections.

Name the counties of the state, bound them and give their county seats. Name the cities of the first, second, and third class. Describe each valley in the state and name the leading city. Name the towns on the Rio Grande Railroad main line; on the branch lines. Name the towns on the Union Pacific Railroad. Name the towns on the Oregon

Short Line Railroad. Name the towns on the Sanpete Valley Railroad. Name the towns on the Mercur Railroad. What is on the Saltair Railroad? How would you go from your home to reach Moab? Kanab? St. George? Ibapah? Salt Lake City? Logan? Vernal? Name the leading mining towns, agricultural towns. Describe Salt Lake City, Ogden, Logan, Provo. Give the reasons for their location where they are.

Describe the state government, also that of your county and town or precinct. Describe the educational system of your county, town, and school. For what is Utah noted?

Topical Review adapted to a General Review of the State, by Sections, such as Salt Lake Valley

(1) Physical Features. — Relief, drainage, water power, climate, water supply, soil.

(2) Natural Resources. — Mineral, scenery, grazing, agriculture, timber.

(3) Industries. — (*a*) Farming, horticulture, dairying; (*b*) saw mills; (*c*) mining: precious metals, copper, lead, iron, coal, building stone, salt, gypsum, oil, rare minerals; (*d*) manufactures.

(4) How are the industries influenced by the relief and natural resources of the region?

(5) Transportation Facilities. — (*a*) How affected by the relief? How laid out in the first place? (*b*) How they have affected the growth of the various towns favorably and unfavorably. How the various industries.

(6) Cities and Towns. — Location and reasons therefor.

(7) Other Facts of Interest. — Antiquities, history, associations, methods of settlement.

Outline for Topical Review of Cities and Towns

(1) Location. — Part of state, county, valley, or mountain range.

(2) Special Reasons for Location and Growth. — Agricultural horticultural, grazing, mining, transportation, etc.

(3) Leading industries.

(4) How does location favor the industries?

(5) Other Facts of Interest. — In what does the city excel? Historical, religious, educational, business.

Reference Books

Report of Fremont's Expedition; Stansbury's Expedition; Irving's works; King's Report on the 40th Parallel; Wheeler's Report; Dutton's Report on the Grand Canyon; Powell's Grand Canyon Expedition; Gilbert's Geology of the Henry Mountains; High Plateaus of Utah; Gilbert's Lake Bonneville; Russell's Lake Lahontan; Reports of the Geological Survey; Reports of the Bureau of Ethnology; Tullidge's History of Salt Lake City; Whitney's History of Utah; Bancroft's History of Utah; Report on Internal Commerce, 1890; Flora of Utah (in Tullidge's Western Galaxy).

TABLES

PRODUCTION OF METALS

	Gold	Silver	Lead	Copper
1880	$165,773	$4,029,501	$641,441	....
1890	699,700	8,492,209	1,895,454	$76,586
1900	4,263,414	6,248,610	3,122,863	2,514,597
1901	3,945,303	6,801,816	3,210,967	3,750,247

Utah stands sixth in the production of gold, and third in silver.

FARM PRODUCTS

	Acreage	Yield per Acre	Bushels	Value
Corn	8,459	20	169,180	$106,583
Wheat	176,895	20.9	3,697,106	2,033,408
Oats	25,577	35.9	918,214	404,014
Barley	5,964	36.5	217,686	119,727
Rye	3,383	17.5	59,202	30,785
Potatoes	5,500	118	649,000	311,520
Hay	192,398	2.65	509,855 tons	4,053,347
Cotton	40	....	13,000 lbs.	934
Sugar	....	....	17,091,220 lbs.	....
Wool	....	....	14,136,981 lbs.	....

PRODUCTS

	Number		Number
Beets, tons	150,000	Alfalfa seed, lbs.	1,200,000

GENERAL STATISTICS, 1901

	Value		Value
Coal	$3,500,000	Dairy	$2,000,000
Asphalt	200,000	Misc.	1,700,000

STOCK

	Number	Value		Number	Value
Horses and Mules.	85,632	$1,874,753	Sheep	2,264,837	$6,150,330
Cattle	348,557	8,576,952	Hogs	53,488	372,114

R.R. Mileage, 1810. Telegraph Lines, 1854. Telephone Lines, 2105.
Street Car Lines, 95. Incorporated Canal Companies, $27,000,000.

DIVIDENDS PAID BY UTAH MINES

Ajax	$1,000,000	Mammoth	$1,870,000
Bullion-Beck	2,479,400	Maxfield	118,000
Cent. Eu.	2,667,700	May Day	18,000
Mercur Con.	2,905,000	Mercur	1,483,000
Carisa	175,000	Ontario	14,782,500
Crescent	280,000	Petro	33,000
Chloride Pt.	5,000	Quincy	1,050,000
Daly	2,925,000	Silver King	4,950,000
Daly West	1,395,000	Sacramento	127,000
Dalton and Lark	350,000	S. Swansea	275,000
Dixie	15,000	Swansea	306,500
Eureka Hill	1,850,000	Utah	192,800
Galena	71,000	Uncle Sam	45,000
Gemini	950,000	Utah Con.	750,000
Geyser-Marion	96,000	Highland Boy, etc.	732,000
Grand Central	691,500	Yankee Con.	75,000
Hornsilver	5,342,000		

TABLE OF ELEVATIONS

	Feet		Feet
Adairville	4,400	Dugway Pass	5,500
American Fork	4,554	E. Tavaputs Plat.	5,500 to 9,500
Antelope Is. Pk.	6,660	Echo	5,480
Aquarius Plat	10,000 to 11,000	Ellen Mt.	11,410
Bear Valley	6,600	El Vado de los Padres Colorado R.	3,194
Beaver	5,916	Emma's Park	7,370
Beaver Dam Mts.	8,100	Emmon's Peak	13,694
Belknap Pk.	11,894	Escalante Desert	5,000 to 5,500
Bingham	5,924	Eureka	6,400
Bingham Junct.	4,366	Fairfield	4,866
Brigham City	4,476	Fillmore	6,025
Camp Floyd Pass	5,234	Fish Lake	8,790
Castle Gate	6,322	Gilbert's Pk.	13,687
Cedar City	5,726	Goshen	4,482
Circle Valley	61,100	Grass Valley	6,200 to 7,500
Clayton's Pk.	11,889	Green River	4,021
Coalville	5,596	Gunnison	5,120
Colob Plat.	8,000 to 9,000	Hardy's	5,487
Koosharem	6,850	Hilgard Mt.	11,460
Cove Fort	6,000	Skull Valley	4,365
Deep Creek	5,025	Ibapah Pk.	12,400
Deseret	4,541	Iron City	6,099

TABLE OF ELEVATIONS (*Continued*)

	Feet		Feet
Johnson's Pass	6,237	Ogden	4,303
Juab	5,019	Panguitch	6,273
Kaibab Plat	6,000 to 8,000	Panguitch Lake	8,136
Kanab	5,072	Park City	6,851
Kanab Plat.	7,000	Parowan	5,970
Kanarra	5,419	Patmos Head	9,830
Kamas	6,304	Pine Valley	5,200 to 6,000
Kimball's, Parley's	6,363	Potato Valley	5,700 to 7,000
La Motte Pk.	12,892	Provo	4,517
Leeds	3,400	Provo Pk.	11,066
Lehi	4,517	Rabbit Valley	6,800 to 7,500
Lewiston Pk.	10,623	Richfield	5,283
Logan	4,509	Riverbed	4,300 to 4,460
Logan Pk.	10,004	St. George	2,880
Lone Pk.	11,295	Salt Lake City	4,300
Marysvale	5,808	Salt Lake Desert	4,220
Mercur	6,700	Sevier Desert	5,000 to 5,200
Milford	4,908	Simpson's Spr.	5,000
Moab	3,900	Soldier Summit	7,465
Monroe	5,380	Stockton	5,100
Montpelier	5,793	Strawberry Valley	7,400 to 8,000
Mount Carmel	5,250	Thistle Valley	5,500 to 6,200
Mount Pleasant	5,875	Tooele Pk. Grantsville	10,396
Musinia Pk., Mollie's Nipple	10,940	Uinta Valley	4,700 to 6,000
Nebo Mt.	11,992	Waas Mt.	12,320
Nephi	5,056	Wasatch Plat.	8,000, to 11,000

POPULATION OF INCORPORATED CITIES AND TOWNS, 1890 AND 1900

	1900	1890		1900	1890
Alpine	520	466	Kanab	710	409
Amer'can Fork	2,732	...	Kaysville	1,708	548
Bear River	362	...	Lehi	2,719	...
Beaver	1,701	...	Logan	5,451	4,565
Bountiful	1,442	...	Mammoth	1,585	...
Brigham	2,859	2,139	Manti	2,408	1,950
Castle Dale	559	303	Mendon	494	...
Cedar City	1,425	967	Mercur	3,251	...
Coalville	808	1,166	Midway	719	...
Corinne	323	...	Monroe	1,057	880
Elsinore	625	...	Morgan	600	333
Ephraim	2,086	...	Moroni	1,224	958
Eureka	3,085	1,733	Mt. Pleasant	2,372	2,254
Fairview	1,119	844	Nephi	2,208	2,034
Farmington	968	...	Newton	429	...
Fillmore	1,037	...	Ogden	16,313	14,889
Fountain Green	755	677	Panguitch	883	...
Glenwood	422	...	Park City	3,759	2,850
Goshen	645	298	Parowan	1,039	...
Grantsville	1,058	...	Payson	2,636	2,135
Gunnison	829	...	Pleasant Grove	2,460	1,926
Heber	1,534	1,538	Price	539	209
Huntington	653	513	Provo	6,185	5,159
Hyrum	1,652	...	Redmond	451	...

POPULATION OF INCORPORATED CITIES AND TOWNS (*Continued*)

	1900	1890		1900	1890
Richfield	1,969	1,531	Smithfield	1,494	1,080
Richmond	1,111	...	Spanish Fork	2,735	2,214
St. George	1,600	...	Spring City	1,135	1,045
Salem	894	527	Springville	3,422	2,849
Salina	847	...	Tooele	1,200	...
Salt Lake City	53,531	44,843	Vernal	664	...
Sandy	1,030	...	Washington	529	...
Santaquin	889	...	Wellsville	908	...
Scipio	578	...	Willard	580	492
Scofield	642	...			

POPULATION OF SALT LAKE CITY

1860	8,236	1890	44,843
1870	12,854	1900	53,531
1880	20,768		

Area of Utah, 84,970 sq. mi. Population in 1900, 276,749.

There are: 2623 Indians; 572 Chinese; 417 Japanese; 672 Negroes.

ASSESSED VALUE, SCHOOL POPULATION, AREA, AND POPULATION BY COUNTIES, 1900

	Assessed Value	School Population	Area Acres	Population
Beaver	$1,174,153	1,119	1,649,000	3,613
Box Elder	5,188,707	3,409	3,488,000	10,009
Cache	5,642,392	4,601	766,000	18,139
Carbon	1,794,971	1,421	975,000	5,004
Davis	3,755,201	2,801	180,000	7,996
Emery	1,324,873	1,734	2,790,440	4,697
Garfield	701,658	1,176	3,248,000	3,400
Grand	1,068,493	239	2,401,000	1,149
Iron	1,137,657	1,227	2,104,000	3,546
Juab	4,080,627	2,508	2,122,000	10,082
Kane	544,867	586	2,716,000	1,811
Millard	2,124,480	1,809	4,265,000	5,678
Morgan	688,098	632	386,000	2,045
Piute	571,828	536	484,000	1,954
Rich	911,010	710	678,000	1,946
Salt Lake	41,028,353	22,427	496,000	77,725
San Juan	312,983	178	5,078,000	1,023
San Pete	4,690,681	5,186	1,003,000	16,316
Sevier	2,029,349	2,869	1,217,000	8,451
Summit	5,041,796	2,663	1,264,000	9,439
Tooele	2,695,243	1,745	4,431,000	7,361
Uintah	1,234,423	1,758	3,329,000	6,458
Utah	10,693,494	11,386	1,363,000	32,456
Wasatch	1,382,582	1,539	2,671,000	4,736
Washington	812,484	1,616	1,562,000	4,612
Wayne	346,550	737	1,529,000	1,907
Weber	11,251,402	8,884	350,000	25,239
			52,541,440	276,749

Negroes 762, Chinese 572, Japanese 417, Indians 2,623.